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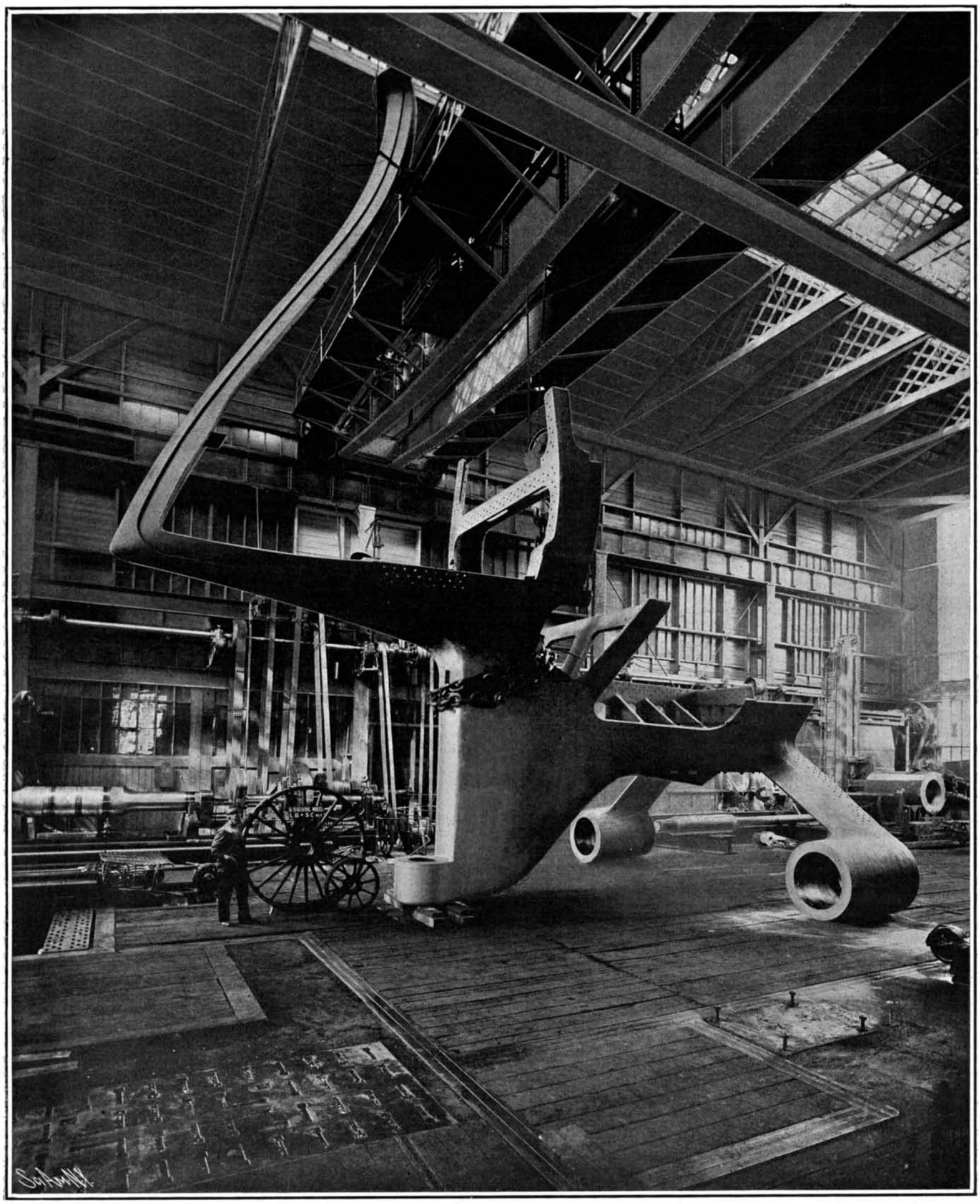

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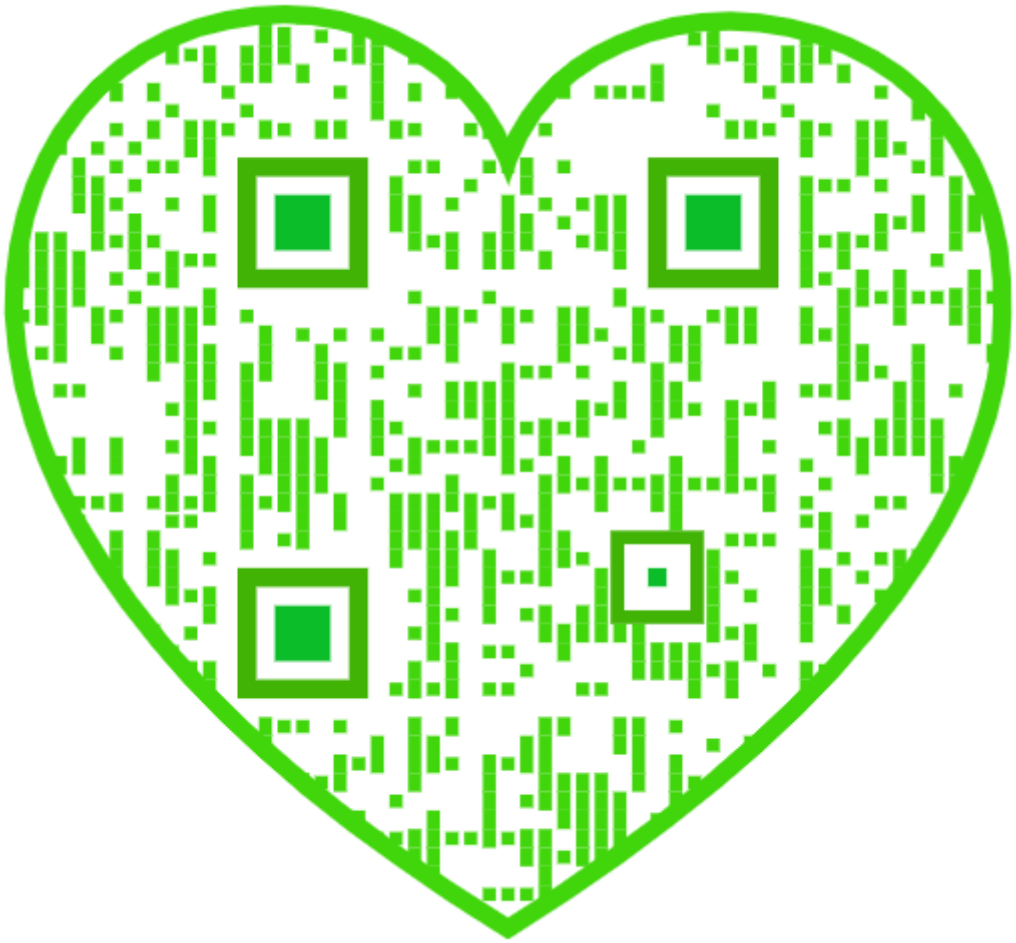

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NEW YORK, SATURDAY, DECEMBER 2, 1905.

The Editor is always glad to receive for examination illustrated articles on subjects of timely interest. If the photographs are *sharp*, the articles *short*, and the facts *authentic*, the contributions will receive special attention. Accepted articles will be paid for at regular space rates.

"FESTINA LENTE."

If we were a people much given to the use of heraldic forms and phrases, the SCIENTIFIC AMERICAN would suggest that the classic saying of Augustus Cæsar, "Festina lente" (Make haste slowly) should be adopted as the motto for the Panama Canal. Never, surely, did the early history of a great undertaking illustrate, in the sequence of its events, the necessity for the exercise of patient investigation and the avoidance of precipitate haste, so clearly as have the past few months of the history of the Panama Canal.

Particularly is this true of the present premature discussion of the forthcoming report of the Board of Consulting Engineers, appointed by the President to determine what is the best type of canal to construct at the Isthmus. This Board is composed of the world's most eminent authorities in the particular class of engineering problems that will be involved in the construction of the canal, and they represent the full knowledge and ripe wisdom of America and Europe in work of this character. The professional reputation of these gentlemen is such as to make it certain that their opinion, as thus rendered, will be given absolutely without personal prejudice, and entirely upon the facts. We take it, therefore, that whatever the Board of Consulting Engineers may recommend as the best type of canal to be built, judged from the standpoint of the engineer, must be accepted by Congress as the best—unless, indeed, the nation is to stultify itself in the eyes of the engineering world. The report has not yet been made public, and cannot be for some time to come, at least in its entirety; and at the present writing nothing is certainly known beyond the bare fact that the decision, by a majority of eight to five, will be given in favor of a sea-level canal.

In view of these facts, we think that it is extremely unfortunate that the press of the country should have been fairly inundated with dispatches from Washington, which not only claim to represent the attitude of individual members of the Board of Consulting Engineers, but also have gone so far as to state that the President himself views the results that have been reached, or are likely to be reached, by the Board, with "great disappointment."

The SCIENTIFIC AMERICAN has the very best authority for stating that, outside of the simple fact that the Board voted eight to five in favor of a sea-level canal, the whole of these dispatches, with their professed statements of facts and opinions, and representations of the attitude of government officials, from the President down, are absolutely and of necessity without a basis of fact. Surely the least that the press and the public can do at the present juncture is to await with some measure of dignified restraint the announcement by the President himself of the findings of his Board. When these are given out, and not until then, will it be possible intelligently to criticise the arguments that are set forth in favor of a sea-level canal.

Speaking broadly, however, and without any reference to the pending report, we would suggest that in all the long discussion which will follow its publication, whether in Congress, by the daily press, by the technical journals, or even upon the lecture platform, it would be well to bear in mind the motto that is written at the head of this article. Let the nation remember that, although the extra one hundred millions of dollars and the few extra years of time that a sea-level canal may cost, may seem large in our day and generation—ten, fifty, one hundred years hence, this little question of time and cost will be forgotten by a posterity that is reaping the inestimable benefits of an unhindered waterway from ocean to ocean.

We are committed to a task, so stupendous both in itself and in its future commercial and political significance, that if we are to judge it rightly, we need to readjust our sense of proportion. To obtain a true point of view, we must take our stand among the future "forty centuries" that will "look down upon" our completed work. We must build for all time.

To a nation that can scatter an annual largess of one hundred and forty million dollars in pensions for a war fought out nearly half a century ago, the question of time and cost in the construction of an Isthmian canal should seem—so we get the best—to be the last consideration.

ADMIRAL PRINCE LOUIS OF BATTENBERG ON SPEED IN WARSHIPS.

In the course of an interview of the Naval Editor of this journal with Prince Louis of Battenberg, Admiral in command of the visiting British squadron, the conversation turned naturally to the subject of speed in warships—for the distinguishing characteristic of this squadron is the unprecedentedly high average speed of over 24 knots an hour, with which every one of the six ships is ready to respond, should the Admiral call for it. Twenty-four knots an hour is a speed which hitherto has been attained only by cruisers of the protected or unprotected type, and the number of these could be counted on the fingers of one hand. That these cruisers of the armored type should be capable of responding to a call for 24 knots is due to the fact that every effort is made to maintain the motive power in such a high state of efficiency, as to enable the ships, when the forced draft is turned on, to develop the same horse-power and show the same speed as were secured on the contract trial. In accordance with a regulation of the British navy, the ships in commission are required, once every quarter, to undergo a 24-hour speed trial, the first eight hours of which is done with the full power, and the remaining sixteen hours at three-fifths power.

Such a regulation naturally begets a desire on the part of the engine room and boiler room staff to equal, and, if possible, surpass the original contract performance; and that this can be done has been proved in the case of this armored squadron, and particularly of the Admiral's flagship, the "Drake."

Prince Louis informs us that the last 24-hour trial was carried out on the recent run of his squadron from Halifax to Annapolis. On the trial with full power, the "Drake" maintained for the first eight hours an average speed of 24.25 knots an hour, with an average indicated horse-power of 31,061, and a consumption of coal (of indifferent quality) of 2.2 pounds per horse-power per hour. The forced draft was then shut off, and for the following sixteen hours the "Drake" maintained an average speed at three-fifths power of slightly over 21 knots an hour. The full significance of this performance will be appreciated by naval men, when it is borne in mind that the "Drake," with full coal bunkers, was drawing 27½ feet, or 1½ feet more than her normal draft of 26 feet, on which her original contract trial took place. Moreover, it is six months since she was last in drydock for cleaning.

The great speed of the "Drake" naturally led to the question being asked as to whether, in the supposititious and altogether unlikely event of hostilities, if the "Drake" were to sight one of the fastest merchant liners, such as the "Deutschland" or the "Kaiser Wilhelm II.," both of 23½ knots speed, she would be capable of overtaking and capturing her. Prince Louis considers that this would be largely a question of the relative ability of the boiler room force on the warship and the converted cruiser to endure for a lengthy period the intense strain incidental to driving the vessels at the highest possible speed. If she had a sufficiently long start, the merchant vessel, because of her large reserve of firemen, and her superior staying powers, might be able eventually to draw away. The result, however, would be determined somewhat by conditions of sea and weather, and on a clear day the "Drake," with her advantage of three-quarters of a knot of speed, should be able, in a calm to moderate sea, to draw up within range, and wing her quarry with her 9.2-inch forward rifle.

Although Prince Louis believes in the great advantage conferred on an armored cruiser squadron by the possession of superior speed, he is of the opinion that the speed given to a battleship should under no circumstances be raised above that critical point at which, on a given displacement, it would become necessary to sacrifice either the armament or the armor, in order to accommodate the great engine and boiler weights that would be necessary to secure that speed. The battleship, heavily gunned and heavily armored, is the central fact about which the other elements that go to make up a navy are grouped; and to which they are, after all, merely accessory and subordinate. The outer screen of scouts and the inner screen of armored cruisers may be considered as having fulfilled their primary function, if they succeed in locating each other's battleship squadrons and bringing them together to fight out the battle of big gun against heavy armor. When the battleships are once engaged, it will be found (always supposing, of course, that the personnel is of equal efficiency) that the ships which carry the most powerful guns and the heaviest armor will survive as victors. Prince Louis considers that in the present day, when the speed of battleships has risen to the high average of 18 knots, the possession of one or two knots higher speed by one of two contending fleets will not offer such a great tactical advantage as is commonly supposed. This is particularly true in these days of long-range fighting, when, as in the late war, engagements may open at a range of as great as seven miles, and be carried on for hours, at ranges of four and five miles. For at such distances it would take a considerable time for a difference of a knot in speed to have any material effect upon the tactical movements of the two fleets.

And after all is said and done, it must be admitted that recent events seem to show that the possession of the "speed gage" is determined, not so much in the designer's office, as it is by the efficiency of the personnel when the ship has been placed in commission. A highly-trained boiler and engine room force, controlled by a staff of ambitious and painstaking engineers, on the one hand, as contrasted with careless and indifferent methods on the other, may easily transpose the "paper" speeds of two contending warships. So that after Admiralty Boards and Boards on Construction have determined what speed a ship shall have credited to her, her actual speed on the high seas will depend upon the day-by-day efficiency of the engineer force.

ELECTRIC MINING IN CALIFORNIA.

Electricity for operating mining machinery has reached a high stage of development in Nevada County, and it is natural that it should typify the progress that California is making in harnessing its mountain streams and utilizing this power for industrial and commercial purposes. It is not that electricity is displacing hydraulic and steam power in the old mines so much as it is that it is opening up new mines that were considered inaccessible and reawakening abandoned mines that could not be operated profitably with steam power. The cost of getting coal up to the mines was in some cases so great that nothing but the richest returns in minerals could make any profits for the company. Before the advent of electricity in the California mining fields there had been developed ideal systems of water and pipe lines and in Nevada County many of these systems are in use to-day. In spite of this, electricity has achieved remarkable results.

The reasons are not far to seek. The mines located above what is called the water line could not be worked, nor could many abandoned mines, which were known to be moderately rich in ore, but that cost too much to work with steam generated from coal. The fuel had to be transported many miles over rough, mountainous country, and its cost at the mouth of the mines often averaged ten and more dollars per ton.

With her fine system of hydraulic generation of electricity in the Sierra Mountains, California leads all other States in the cheap distribution of electric power. Gold mines all along the route of her long-distance transmission lines have been converted into active scenes of mining. Lateral lines of transmission run in all directions, and some of these extend upward of twenty and thirty miles from the main route. So great has grown the demand for electricity for mining purposes that the supply of power for the Pacific coast end of the transmission lines is seriously menaced. The application for electricity for new mines increases with each month, and several new mines call for electricity every few weeks.

The water power of California is thus its most precious heritage. So important is this considered that its distribution has been developed into a system that makes both miners and farmers dependent upon it. The location of a mine or farm is therefore the important consideration in opening and working it. Water is sold and distributed at so much per miner's inch throughout the State. This appears on the surface a very equitable system, and it was, before hydraulic power was introduced for generating electricity. The sale of the miner's inch of water has no bearing whatever upon the head of the water. One farmer or miner pays the same for the water as another who is located 100 or more feet lower down in the valley. As each inch used had to be paid for, it was not considered necessary to take into consideration the pressure of the water.

This condition of affairs has created some peculiar results. The miner or farmer who uses the water in the higher altitudes loses a power which another some hundred feet below can convert into electric power for mine purposes. There are a number of instances where one mine develops something like 0.19 horse-power for each miner's inch of water, and another 500 feet lower down secures 1.19 horse-power at the same cost for the water. We find, therefore, that the generation of electricity on a large scale in the lower valleys is more economical than in small units near the camps higher up. Most of the power-house companies can transmit electric current to the higher camps at less cost than

the latter can generate it, no matter how efficient the water-wheels and motors may be.

In Nevada County there is nearly 5,000 electric horse-power used for mine operation. The power house on the South Yuba supplies most of the mines with its electricity, but individual companies and groups of mines have organized in the last year to develop their own electric current. There are a number of streams in the mountains which have a head varying from 300 to 800, and the harnessing of these assures permanent cheap power for the mines. On the South Yuba there are two 600-horse-power plants working under 800 feet head, and the current is used almost entirely for mine purposes. The original machines in this region, consisting of two 330-kilowatt motors, are still in active operation, one working at 190 feet head, and the other at 800 feet.

In Grass Valley there is one mill that is driven entirely by electric synchronous motors. There are forty stamps and sixteen concentrators operated there, and the current is transmitted from the distant power house and sold by meter. It has been found that electricity operates a quartz mill cheaper than any other power.

There are some rather anomalous conditions to be found in Nevada County where electricity has displaced steam. All the mining machinery was formerly driven by steam, and the work of displacing steam was slow. In order to save the old machinery the engineers adopted many peculiar devices. But electricity has triumphed, and steam is practically abolished owing to the high cost of fuel. The direct-current motors are used for pumping in connection with compressed air, and also in a more limited way for driving drills. It is doubtful if compressed air for driving drills, pumps, and a few other machines will be displaced by the electric motor. In drilling with compressed air it has been found that the exhaust air proves of great value in ventilation. Electric drilling cannot offer such advantages unless worked in combination with a system of electric fans. While electricity is used for driving the compressors, working the mine house hoists and operating pumps, it has so far made little progress in drilling. Electrically-driven mine pumps have proved popular and profitable in this region, and two new ones are being installed, one at the 700-foot level and another at the 1,000-foot level. The success and profits of these new large pumps will naturally influence the construction of others, for mining companies are quick to note the practical advantages of any new departure.

In the matter of ventilation by exhaust fans, the mines are still inadequately supplied, but their introduction is being steadily pushed. Estimating current at ten cents per kilowatt-hour, the cost of exhausting 1,000,000 cubic feet of air by the slow-speed blower has been found to average 44.2 cents, and by the high-speed blower only 17.2 cents. The installation of the latter in preference to the former is therefore an assured fact, and a number of 20 horse-power motors are used for driving fans from six to nine feet in diameter.

HOW MUCH DOES THE UNIVERSE WEIGH?

BY PROF. EDGAR L. LARKIN.

The laws of attraction, motion, and centrifugal tendency are known in every detail, and with great accuracy. Three centuries of mathematical investigation revealed all their mysteries. The attractions and motions in this note are those in free space, between the distant stars. When one cosmical body is seen revolving around another, as sun about sun, or planets around suns, the combined mass of both may be easily determined, if the distance of the earth from the flying bodies is known. For the quantity of matter required to exert attraction sufficient to impart any velocity to any body at any distance is known to mathematicians. Thus, suppose the sidereal structure to have a boundary, and that its distance from the earth is known. Imagine a body entirely outside, to be in motion, falling toward its center of gravity, then if the speed and distance of the falling body could be discovered, the entire universe can be "weighed," that is, the quantity of matter it contains is capable of computation. Or, if the location of the center of gravity of the stellar hosts could be detected, and a sun should happen to be flying through it, then, again, the mass of all the stars could be found, if the speed of the moving sun and its distance from us were known.

All suns are in motion; it is impossible for one to remain at rest. If one is coming toward the earth on a straight line, or receding, the spectroscope—that marvel of all ages, and one of the most powerful engines in the hand of man for the conquest of the universe—tells its velocity of approach or recession. If a sun is flying through waste places in space, in a direction at right angles to a line drawn to it from the earth; its motion can at once be measured with a telescope and micrometer. And if the directions of stellar motions make angles with this line, the motion can be resolved into component parts by the usual formulas.

Careful research has long been made on the star No. 1830 in the catalogue of Groombridge. It moves with an angular velocity of seven seconds of arc per annum. There are 1,296,000 seconds in every circle, which divided by 7, equals 185,000, or the number of years required to traverse the circumference of the celestial vault. The distance of this star is not known with accuracy. Some catalogues omit its parallax, others say 0.1 sec. and another 0.13 sec. If exactly 0.1 sec., its distance from the earth would come out 2,062,650 times greater than that of the sun, or 192 trillion miles. So it will be taken at 200 trillion; for calling it 190 or 210 will not make an error in the result greater than an infinitesimal of the first order. And with a distance of 200 trillion miles, and a period of revolution of 185,000 years, the terrific orbital velocity of 200 miles per second appears. This is absolutely overwhelming even to the trained minds of those accustomed to revel in great numbers. The object now sought is to find the quantity of matter within a sphere having the diameter of this mighty orbit, 400 trillion miles. Perhaps the simplest way to get at this is to find the centrifugal tendency set up by this orbital speed. If the star moves on a circular orbit, this tendency equals the attraction of all the matter within. The same is true of an ellipse with the proper modifications for eccentricity. Tie a cord to a stone, and whirl it around the hand. The pull on the string is centrifugal tendency, and is equal to the square of the velocity of the stone, divided by the length of the string from the hand to the stone. And 200 squared equals 40,000, which divided by 200 trillion gives a quotient of one-five-billionth.

That is, the centrifugal tendency is equal to an acceleration of the one-five-billionth part of a mile per second. This is cleared by saying that if the star could come to an absolute rest, then it would instantly start to fall toward the center of gravity of all the matter inside of a sphere having a diameter equal to that of its orbit. And at the exact end of the first second of its fall, it would be falling with a velocity of one five-billionth of a mile per second. The fall would be due to gravity; but as it does not approach the center, but keeps on its orbit, the centrifugal tendency exactly balances the attraction. Thus in this roundabout way, the force of gravity exerted by the matter acting on the star is found. So far, no idea is had of the quantity of matter able to impart this velocity to a falling body 200 trillion miles from its center of mass. It is possible to approach the problem by comparing this force and distance with a body whose attraction and distance are known. Suppose our sun is selected for trial. Take a stone to within one mile or so of the sun and drop it. At the end of the first second, it will be falling with a velocity of seventeen hundredths of a mile per second. This is the well-known velocity potential of the sun, and is called, for short, "solar gravity." Now it must be found how fast the stone would be falling at the end of the first second, if taken to a distance of 200 trillion miles and let fall. Gravity varies inversely as the square of the distance. So the 0.17 of a mile divided by the square of the distance to 1830 Groombridge will give the desired quantity. But it would never do to divide the 0.17 by 200 trillion squared, but by the square of its ratio to the radius of the sun, which call 400,000 miles.

This is not obscure, for a stone falling on the sun's surface is 400,000 or more miles from the center. This is equal to one (1). To find the ratio, divide 200 trillion by 400,000. The quotient is five hundred million, whose square is 25 quintillion. Now everything is ready to find the mass of matter within the orbit of the star. For 0.17 divided by 25 quintillion, equals 0.00000000000000000068 of a mile per second velocity the mass of the sun could impart to a falling body at the end of the first second of its fall, at a distance of 200 trillion miles. But one five-billionth is enormously greater than this minute decimal. By actually dividing the greater by the less the appalling quotient of three hundred million is obtained, that is, there must be 300,000,000 times more matter acting on the star than is contained in our sun! And the sun contains 333,000 times more matter than is contained in our little world—our earth.

All these results are based upon the theory that the rapid star is moving around our sun in a regular orbit, and on the further hypothesis that no other matter exists. There is an untold quantity of matter in countless suns farther away, by far, than 1830 Groombridge. And it is not known whether the wandering sun is moving on a circular, or elliptical orbit, or on a straight line. But if on a straight line, the consequence is, that the 300,000,000 suns sink and wane away into the abyss of insignificance. See my article, "Velocity Potential of the Universe," SCIENTIFIC AMERICAN, February 18, 1905. It was there shown that if this star is moving on a straight line, and if it has been falling "forever," that is, having fallen from an "infinite" distance, and is now near the center of the sidereal universe, then the quantity of matter required to impart this colossal speed is thirty-two billion times that now contained in our modest sun. And how does a mere 300,000,000 compare with 32 billion? This computation is grounded on the hypothesis that the universe has a finite diameter of such length that light moving with the known velocity of 186,000 miles per second, requires 30,000 years to traverse it. But it matters little whether the edifice of stars is larger or smaller than this, the astounding fact is here—the star is moving with this frightful speed. And this motion has a mighty cause equal to the occasion. The quantity of matter capable of exerting this intensity of attraction is so far beyond the powers of mind, that there is no use beginning to think about it. Only one hundred million suns appear on the photographs of the entire celestial vault. Therefore, the *visible* universe is so utterly insignificant in comparison with the *invisible* that mathematicians are overwhelmed.

SCIENCE NOTES.

The International Aerostatic Commission has been holding its meetings at Paris, and these were closed during October. An important part of the work of the commission has been in forming a union among all the countries which are represented on the present occasion. This union will bear the name of International Federation of Aero Clubs and will have its headquarters along with the commission. At the recent meetings a series of international rules were adopted which had been drawn up by the Aero Club of France. But the regulations concerning the airships have been reserved for a future time. The next meeting of the International Commission will take place at Berlin in 1906.

The Governor-General of Egypt has promulgated an ordinance by which the government exercises its right of possession of any archæological remains and antiquities discovered in the Soudan, comprising buildings, monuments, remains, or objects of whatever age or people, which are illustrative of arts and sciences, industries, religion, history, letters, and customs, and that were built, made, or produced in the Soudan, or brought thereto prior to the year 1873 of the Gregorian calendar. Although the law is limited to the year 1873, the Governor-General is further empowered to declare right of possession to any object whatsoever in, or attached to, the soil after that year. This decree will deal the deathblow to the Egyptian "faker" and his nefarious traffic in coins, papyri, and other spurious antiquities, in the sale of which he plies a thriving trade during the winter season among the credulous tourists.

A very convenient process of obtaining a dilute solution of hydroxyl has been described by Dr. J. F. Jaubert, an eminent chemist of Paris, who is already known for his preparation of "oxylith," by which oxygen gas is formed from water. The present process originated by observing the action of boric acid upon peroxide of sodium. If we pour a powder formed of a proper mixture of boric acid and peroxide of sodium into water; the powder begins to dissolve, but after a certain time a crystalline deposit is formed which seems to correspond to the formula $B_4O_8Na_2 + 10H_2O$. This body gives hydroxyl by simply dissolving it in water, according to the reaction $B_4O_8Na_2 + H_2O = B_4O_7Na_2 + H_2O_2$. The solution keeps well without decomposing rapidly. After a month it still keeps 56 per cent of the original active oxygen. M. Jaubert calls the crystalline substance which is thus isolated by the name of *perborax*. When recrystallized for a number of times it forms crystals which contain an increasing quantity of active oxygen, and we find thus another compound, $BO_3Na + 4H_2O$, known as *perborate*. It keeps indefinitely when dry, and gives hydroxyl by simply dissolving it in water, but this solution is alkaline, and it must be prepared just when it is needed. The perborate has antiseptic properties, and can be used in surgery.

Some interesting researches in the treatment of rabies by the rays of radium have been made by two Italian savants, Tizzoni and Bongiovanni. In some cases they act upon the virus itself, and in others upon the animals. By exposing the virus to the radium rays it is rapidly transformed into a very active vaccine. The exposure varies from four to thirty-six hours. When a drop of the vaccine is injected into the animal's eye, he is found to be protected against the inoculation with a dog's virus such as readily killed the other animals. As to animals which were already under the influence of the virus, the seances of radiotherapy (one hour each) must be commenced at least ten hours after inoculation. But by a powerful sample of radium, and a series of exposures of several hours for six days, they find that they can save animals even forty-eight or one hundred hours after inoculation, while the animals used for a check on the method all died. Especially striking are the experiments with the rabbit, where it succumbs rapidly to the virus. Under the radium treatment we see the nervous phenomena retrocede and the fever diminish, with a gain in weight. The effects thus disappear in one case, while with a second animal, untreated, they go on increasing at the same time and soon end in death. This new application of radium will no doubt prove valuable.

THE PHOTOBIOGRAPHY OF A CHIMNEY.

BY EDGAR MELS.

The second highest chimney in America has been completed for Heller & Merz Company's plant at the foot of Hamburg Place, Newark, N. J. It is 350 feet high, just 15 feet less than the stack of the Orford Copper Company at Bayonne, N. J., but it is said to be a far finer piece of structural work. As its cost would seem to indicate—$35,000, or $100 per foot of height—it is as complete as the best of material and labor could make it. Aside from these features, it is an engineering feat of no mean proportions, for it is built on the treacherous salt meadows just to the east of Newark, and this despite its weight of 3,000,000 pounds.

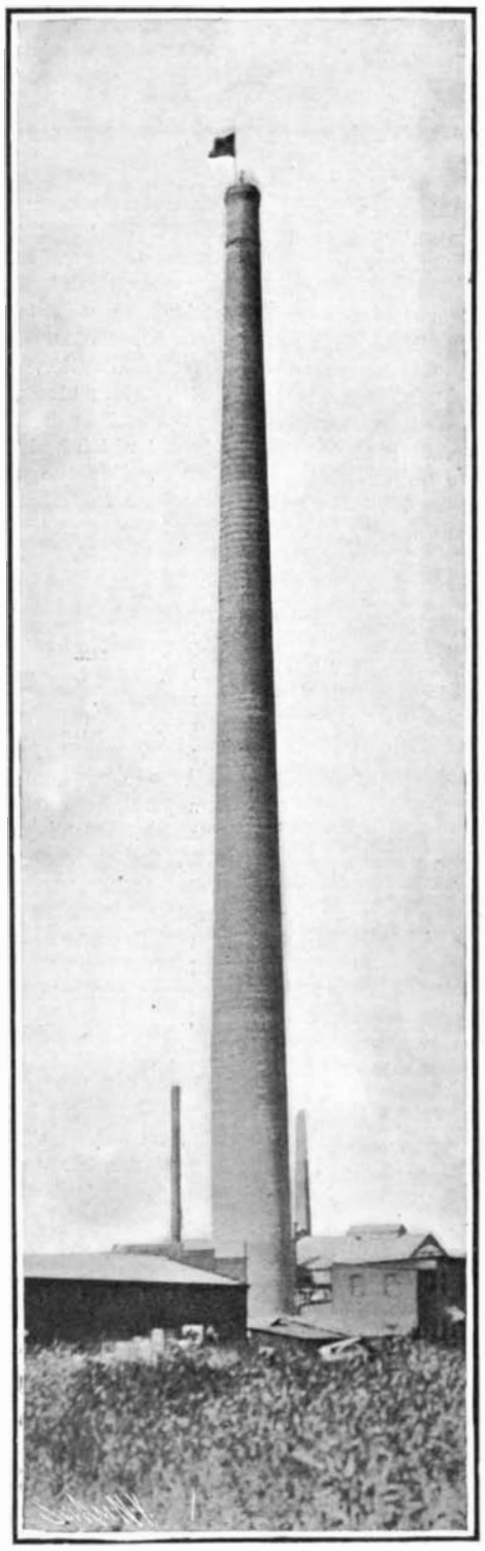
The building of this stack has pleased the lower portion of Newark, not only because it promises to remove the objectionable odors emanating from the color works, but because it was constructed solely for this reason, and not because of legal interference, or threats of the local board of health. As long ago as 1903, Eugene and August Merz, of the firm, decided that in view of the rapid growth of the city in the vicinage of the works, it would become necessary sooner or later to increase the height of their present stack—only 60 feet high; so plans were drawn for the present chimney. Plans of all the tall chimneys here and abroad, especially one in Glasgow, Scotland, which is more than 400 feet high, were carefully considered, and then the final diagrams drawn.

Next came the borings to determine the quality of the ground in which the foundation was to be built. Four holes were driven down for a distance of 60 feet, when red shale was struck. The first 4 feet was found to be the usual filling, followed by 6 inches of meadow roots and by 18 inches of clay. Then came 10 feet of coarse sand, of good quality, but containing so much water as to render it of almost the quicksand variety. Soft red clay followed, until the shale, better known as Jersey red rock, was struck. At the southern end, this was found at a depth of from 30 to 35 feet, and at the northern, at 60 feet.

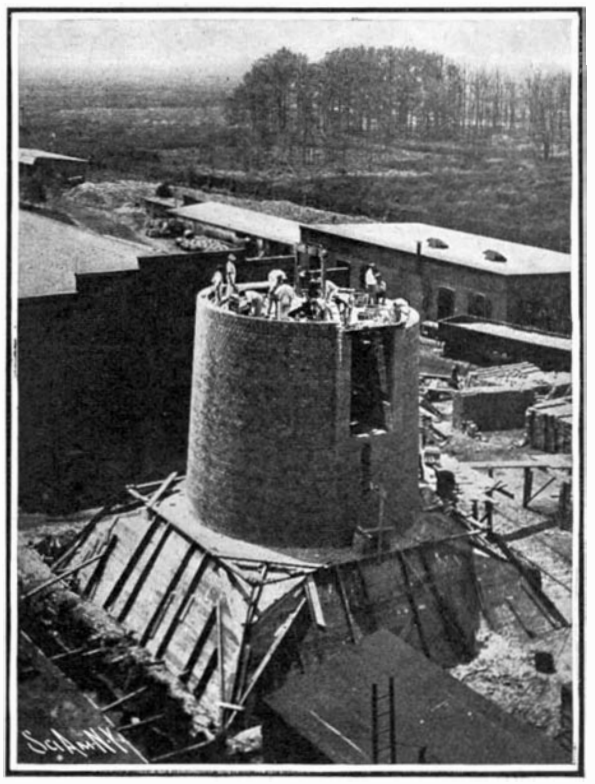
What is said to be the tallest land pile-driver in use was employed to drive the 60-foot piles. There were 324 of them, of the best Virginia yellow pine, with the top 14 inches or more in diameter. The driver, 70 feet high where the weight drops, carried a weight of 3,000 pounds, limited to a drop of 15 feet, to prevent shattering of the piles. This blow was greatly reduced when the piles showed the slightest sign of having reached the shale. The utmost care was taken in placing this timber 6 feet 6 inches apart from center to center. When the entire lot had been sunk, they occupied a space 45 feet square. They were then cut off 2 feet below the permanent water level, and their tops sunk one foot in the concrete base, composed of one part cement, three sand, and five stone. Every twentieth bag of sand was sampled, the fineness of the cement was determined by special screens and with a boiling-water test, and briquettes made of the concrete tested every seventh and twenty-eighth day.

The concrete base, containing 21,000 cubic feet of concrete, is 10 feet high. To build it were required seventeen cars of crushed stone, or 510 tons; ten cars of 30 tons each of sand, and 4,000 bags of Portland cement. The concrete base was finished on May 23 of this year, having taken just three weeks to construct. The first brick was laid May 31, and the last September 18. The chimney itself is of the best pale red, segmental brick, the total number being estimated at about 950,000. There are 44,000 cubic feet of masonry in the shaft, which, if piled into one heap, would make a pile 100 feet long, 22 wide, and 20 deep. The bricks vary materially in size and shape, some ranging from 5 by 8 by 6 inches to 5 by 6 by 5, according to location. The work was carried on without interruption, scaffolding being used by the laborers. There was only one mishap, a brick falling from the 210-foot level, hitting the ground, and on bouncing, striking a workman, whose arm it broke.

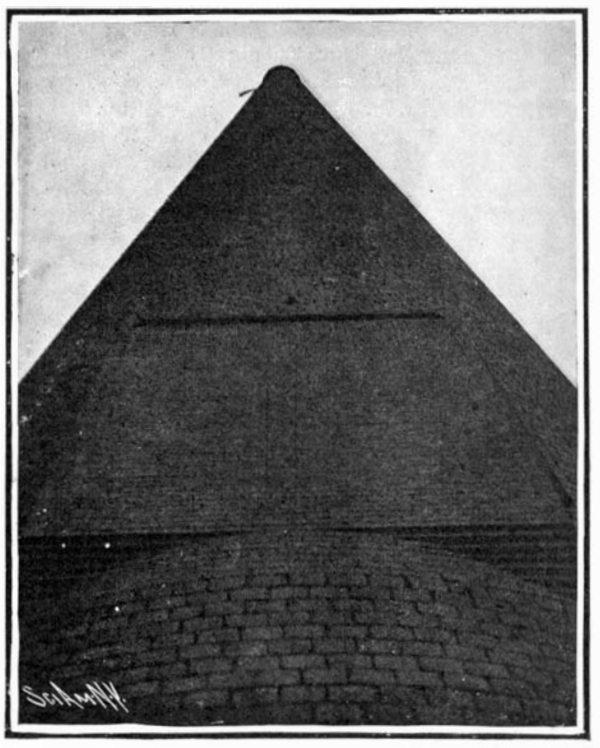
As it stands to-day, the chimney is 27½ feet in diameter at the bottom, the interior measurement being 20 feet, and 9 feet 10½ inches at the top, with an inside diameter of 8 feet. It is lined with hard-baked red brick, set 2 inches from the wall, and is built in four sections, so that any one section may be repaired, should the occasion require. The stack was built to withstand a wind pressure equivalent to 19 tons to the square foot resultant pressure at the base. It was constructed by the Alphons Custodis Chimney Construction Company, of New York city, and under the personal supervision of Eugene and August Merz of the firm, both engineers. The accompanying photographs, taken by Mr. August Merz, represent the stack at various phases of its construction.



The 350-Foot Chimney. The Second Highest in America.

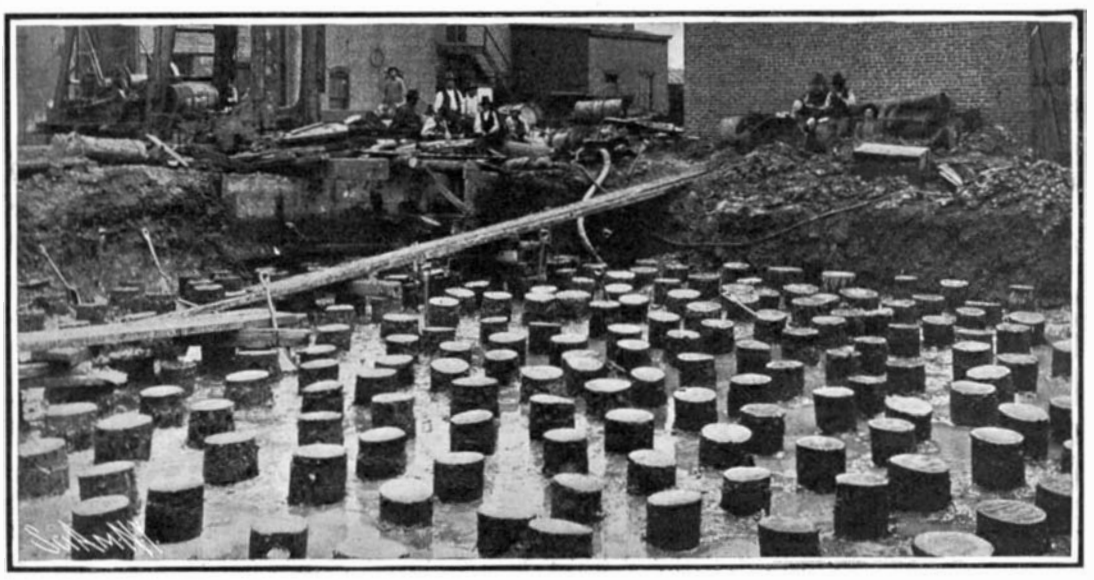


Base of Chimney, Showing Flue Opening.



Looking Up at the Completed Chimney.

The little speck at the left of the apex is the American flag.



Excavation 4 Feet Below Grade, with Piles Cut Off 3 Feet Below Grade, Ready for Concrete.

THE PHOTOBIOGRAPHY OF A CHIMNEY.

Theory of Bichromated Gelatine.

The composition of bichromated gelatine which has been made insoluble by adding salts of the sesquioxide of chromium, is brought out by two prominent photographic chemists of Paris, Messrs. Lumière and Seyewetz, and they treat also of the theory of the action of light upon gelatine containing metallic chromates. The conclusions of the different experiments which they made in this field may be summed up as follows: First, when gelatine is treated with salts of chromium, it seems to fix the chromium directly, seeing that its properties undergo profound modifications and that the chromium cannot be eliminated after numerous washings with boiling water. Second, the acid of the chromium salt, although it is retained with energy by the gelatine, does not seem to enter at all into the phenomena we observe where the gelatine becomes insoluble, seeing that we can eliminate the acid without modifying the properties of the insoluble gelatine. We may suppose that it is owing to the functions of the gelatine, which are both basic and acid, that it can retain at the same time the oxide of chromium and the acid which is combined with it. Third, a given weight of gelatine will fix a maximum constant quantity of sesquioxide of chromium comprised between 3.2 and 3.5 per cent of the weight of the gelatine, regardless of the nature of the chromic salt which is used for making the gelatine insoluble. Thus it seems that we have to deal with a well-defined compound in this case. Again, seeing that it is easily dissociated, the insoluble gelatine is rather an addition compound than a veritable combination. Lastly, the dissociation of the bichromatized gelatine by successive treatments of boiling water can be prevented either by washing the treated gelatine in the proper way with ammonia water or again by adding to the gelatine (before putting in the chromic salt) the theoretical quantity of ammonia needed to saturate the acid of the salt.

The British Automobile Club have decided to hold trials for tires and lamps next year.

UNITED STATES NATIONAL BUREAU OF STANDARDS.

ITS STANDARDS OF MASS.

BY HERBERT T. WADE.

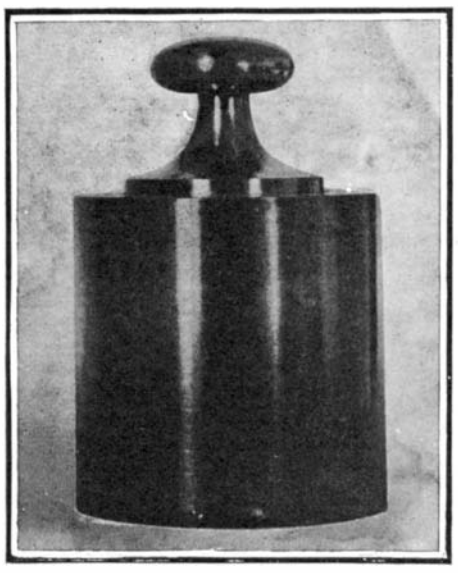
In making any ordinary measurement, as for example of a length, or in weighing a quantity of a substance, it is quite usual for the average person to take for granted the accuracy of the scale or rule, or the correctness of the weights. So generally is this the practice among non-technical people, that it is only some such unusual occurrence as when municipal inspectors or other persons detect people using fraudulent weights and measures, that attention is directed to their accuracy. Assuming, as he does, and usually with justice, that his weights and measures are correct, the average man may desire to know how this is brought about and the reason for his confidence. By correct is meant that the weights or measures must be equivalent to certain standards which duly constituted authorities have adopted as representing the national units, and to them all other standards of measurement must be directly or indirectly referred. Thus the maker of two-foot rules sees that each individual rule he makes conforms to his shop standard, and this in turn must correspond with, or be known in terms of, the national standard of length. And now if there is any doubt about any weight or measure, a citizen of the United States can send it to Washington, and on payment of a nominal fee have it determined and certified to under seal by a branch of the national government established for this purpose. This is the Bureau of Standards, which was constituted in 1901 to care for the national standards and for performing other duties involved in scientific measurement and research. Succeeding as it did to the duties of the old Office of Weights and Measures, for many years a part of the Treasury Department in charge of the superintendent of the Coast and Geodetic Survey, this new bureau on its organization was also attached to that department; but in 1903, on the establishment of the Department of Commerce and Labor, it was made a part of the organization of the latter. This bureau has during the year moved into new and specially-equipped laboratories located in the suburbs of Washington, where its rapidly-increasing work is now in active progress.

The first function of the bureau is to care for the national standards, and arrange for their comparison and reproduction. Thus the standard of mass for the United States, by executive order of April 5, 1893, is the international prototype kilogramme as represented by the standard kilogrammes received from the International Bureau of Weights and Measures at Sèvres near Paris. Despite the fact that the Anglo-Saxon weights and measures are customarily used, a legal avoirdupois pound must be derived from the kilogramme by using the ratio 1 pound avoirdupois = 1/2.2046 kilogramme. The standard kilogramme, which is illustrated in Fig. 1, is one of two owned by the United States, and is made of platinum-iridium, being of cylindrical shape. It is preserved under two glass bell jars, whose edges are carefully ground so as to make a practically air-tight joint, the general arrangement being as shown.

It is obvious that standards such as this kilogramme cannot be used constantly or exposed to changes of temperature and atmospheric conditions, but must have the most careful treatment, and be reproduced in the form of secondary standards, whose constants are all accurately known and which can be used in the laboratory. Accordingly the national prototypes of length and mass, together with other standards of historic value, are preserved in a vault in the Bureau of Standards, which not only is fire-proof, as is the entire building, but can be entered only through steel burglar-proof doors, the combination of whose locks is known only to the director and the physicist in charge. The outer door bears the coat of arms of the United States, and while the vault is safe from any danger, yet it is artificially heated and ventilated, so that its temperature and humidity are kept constant through automatic thermostats. In this way conditions are realized that are superior to those in subterranean constant temperature vaults, where dampness is often an unpleasant characteristic. This apartment contains nearly all the standards that have figured prominently in the United States since the foundation of the government, and among them are various metric, British, and other weights and measures standardized in these countries, and often the gifts of the respective governments. When the standard kilogramme is removed from the vault, it is for the comparison of secondary standards of mass, and this operation involves the use of a delicate vacuum balance, from which the air is exhausted before a weighing is made. This type of balance, of which the bureau possesses several in its most recent form, is shown in Fig. 2, though the photograph does not show the telescope through which the vibrations of the beam are observed, or the mechanism by which the experimenter controls the various operations; for the observer stands at a distance of twelve or fourteen feet, and is able to perform all the necessary operations merely by manipulating a series of rods and levers. Thus the balance can be released, the rider added to or taken off from the beam, and the two weights interchanged on the pans without approaching the apparatus or opening the case. This eliminates effects due to the temperature of the observer's body, while the mounting of the balance itself, either on a firm wall bracket or on a massive pier with independent foundation, reduces to a minimum any vibration. Nearby in the balance room is a similar balance (see Fig. 3) but arranged for the comparison of masses up to 50 pounds or 25 kilogrammes, the mechanism in this case being also inclosed in glass and largely automatic, though of course the refinements are not required in this instrument that are involved when the national standards are being used. Such a balance would be used in standardizing the heavier weights of inspectors of weights and measures. The bureau has in its collection numerous standards of mass, among which perhaps the most interesting are the British gun-metal standard pound of 1855 and the earlier standard kilogramme shown in the illustration.

British Bronze Standard Avoirdupois Pound.

Presented to the United States in 1855 by the British government.



Silbermann Kilogramme.

Presented to the United States by the French government in 1852.

One of the important functions of the bureau is to standardize weights for local sealers of weights and measures and inspectors, as well as for such other purpose as they may be required, and it makes a specialty of adjusting weights which have been constructed by instrument makers to serve as standards. These must be plated with gold to prevent oxidation before they are submitted to the bureau for test, and in case they meet the requirements, suitable certificates are issued to accompany them. The weights tested are both the Anglo-Saxon or usual weights and those of the metric system, and in this way a connection is made between the national standards which are metric and those of ordinary use. While the standards of weights and measures for the United States are national, and are fixed under the authority of Congress, yet the legislation dealing with their use and providing against fraud is enacted by the various States. Consequently, each State has its own sets of standards, both customary and metric, which in the majority of instances have been supplied by the national government; and in addition to statutes providing against the use of false weights and measures, there are in each town or county local sealers or inspectors of weights and measures, who inspect the weighing and measuring appliances of the tradespeople. Thus a comparison is made with the official measures and weights, so that on the vigilance of these officials and the accuracy of their standards depends the correctness of the weights and measures of a community. Therefore it has seemed fitting to the officials of the Bureau of Standards to devote considerable attention to the best apparatus and methods for such testing, and it is now prepared to assist local sealers and inspectors, and standardize for them the weights and measures they employ. In addition the bureau is aiming to secure uniformity of method and increased precision by the distribution of information and by practical co-operation wherever possible. Thus by working through manufacturers both of standard and ordinary weights, and then by co-operation with the local authorities, it hopes to preserve and increase the accuracy and reliability of the weights and measures of the general public. Furthermore, if a change to the metric system should ever be made, as is constantly being urged by various metrological reformers, the machinery to carry out such an innovation with maximum efficiency will be found to be in complete and practical working order.

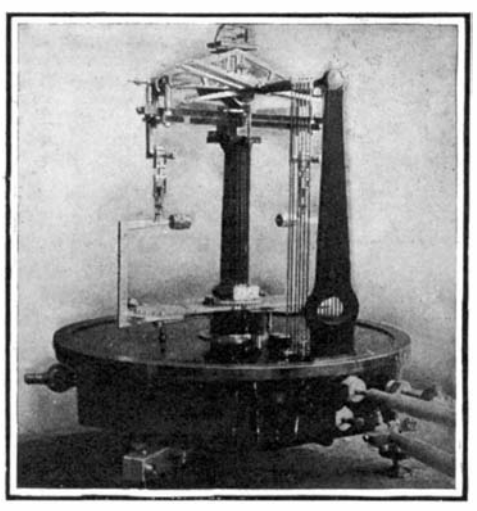


Fig. 2.—Stückrath Vacuum Balance for Comparing Standard Kilogrammes.

Sensitive to a small fraction of a milligramme. The cover is removed.

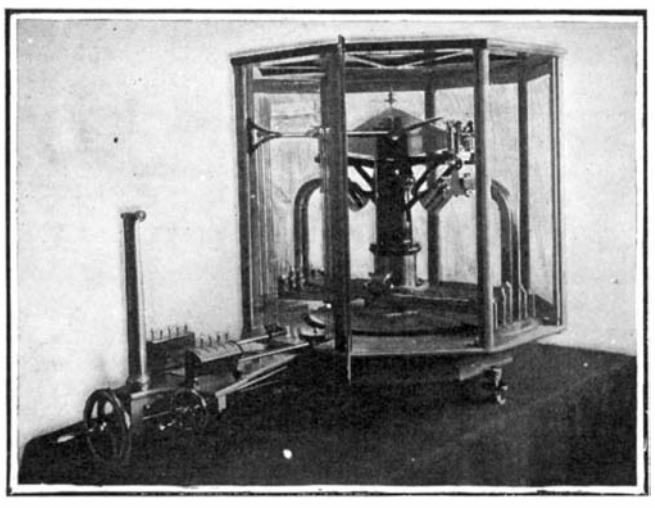


Fig. 3.—Stückrath Balance of National Bureau of Standards.

With a load of 20 kilogrammes this balance will show a difference of 1 milligramme in the two weights.

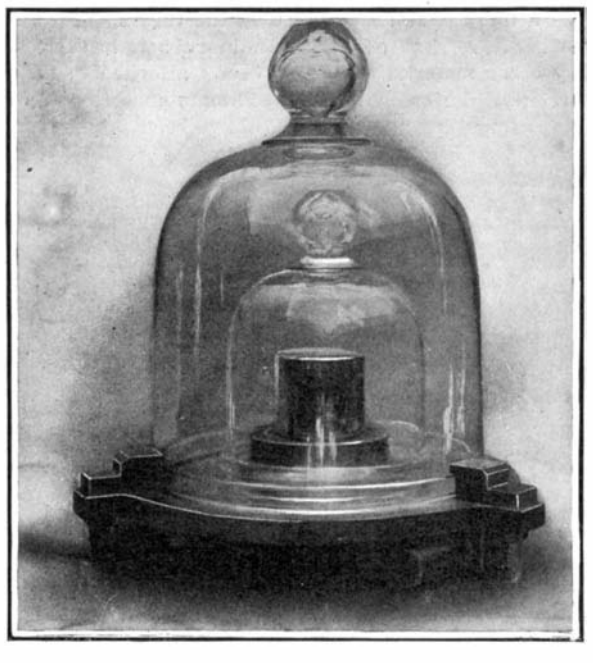


Fig. 1.—International Standard Kilogramme.

One of forty constructed by the International Bureau of Weights and Measures and the standard of mass of the United States.

UNITED STATES NATIONAL BUREAU OF STANDARDS.

The masonry of the Simplon tunnel and ballasting of the line are to be completely terminated by the end of the present year, and it is hoped that the opening will take place on April 1 following, so as to coincide with the opening of the Milan International Exhibition.

STERN FRAMES AND BRACKETS FOR THE NEW CUNARDERS.

The view which we here publish of the stern frames and brackets of the new Cunarders gives an impressive idea of the great proportions of these two ships. As our readers are well aware, the Cunard Steamship Company is having built for its transatlantic trade two high-speed mail and passenger steamers which, because of their great size, high speed, and the fact that they will be equipped with turbine engines that will greatly exceed in size and power any engines of that type yet constructed, are entitled to stand in a class by themselves. These vessels will be 800 feet long, 88 feet broad, will have a molded depth of 60 feet, and a displacement which, in spite of the exceedingly fine lines of the boat, will reach 43,000 tons. The contract speed is 24.5 knots, which is to be actually maintained from port to port, as one of the conditions of acceptance. It is probable, however, that the trial speed will run up to 25.5 or even 26 knots.

One of these vessels is being built on the Clyde, at the yard of Messrs. J. Brown & Co., and the other at the Wallsend yard of Swan & Hunter. The accompanying illustrations represent the steel frame and brackets for the Cunarder which is building on the Clyde. They are shown erected in the shops of the Darlington Ford Company, by whom they were cast. These pieces are by far the largest constructed for any ship. The stern frame alone, in completed condition, weighs 47 tons, and about 70 tons of molten metal were required to cast it. The after brackets, shown attached to the stern-frame casting, were cast singly, and each one of the pair weighs 22½ tons. The forward brackets (the Cunarders are quadruple-screw vessels) each weigh 24 tons. The rudder will be a truly enormous affair, its stock being 26.8 inches in diameter, and its weight finished and fitted to the ship will be 70 tons. The total weight of the stern frame, as shown in our engraving, is 100 tons, and the aggregate weight of the rudder, stern frame, and four brackets will be about 220 tons. It took two months to make the mold in which the stern frame was cast, and six months more to complete the finished castings.

The great dimensions of the work are shown by the scale afforded by the man who is seen standing beside a driving wheel of one of the London, Brighton, and South Coast Railway locomotives, which is 6 feet 9 inches in diameter. The height from the bottom of the rudder blade to the top of the stern casting is 55 feet.

Some Effects of Alternating Currents on Dogs.

BY MYRON METZENBAUM, M.D.

Within the past year in Cleveland an unusual number of linemen came in accidental contact with "live wires," resulting in their death. This subject attracted the attention of Dr. George W. Crile, professor of surgery, and Dr. J. J. R. Macleod, professor of physiology of the Western Reserve Medical College, and they undertook a series of experiments to determine the effects of alternating currents of moderate frequency on dogs. The full details of the experiments were published in the Journal of Medical Science for March, 1905.

The strength of the current varied from 1,000 to 2,700 volts alternating current. The electrodes were placed at various points on the dogs, and the current allowed to pass from an instant up to 4½ seconds. The chief points of interest drawn from these experiments are as follows:

1. The variability of the strength of the current necessary to produce death depends on the path through the body traversed by the current.

2. If the heart lies in its path, fibrillary contractions of the heart muscle result; if not, there is only inhibition of the vagus nerve governing the heart and respiration.

3. Currents passing between electrodes placed in the mouth and rectum necessarily traverse the heart, and are always fatal.

4. With electrodes placed on the head and hind limb, most of the current will pass along the tissues about the spinal column, and will frequently pass by the heart.

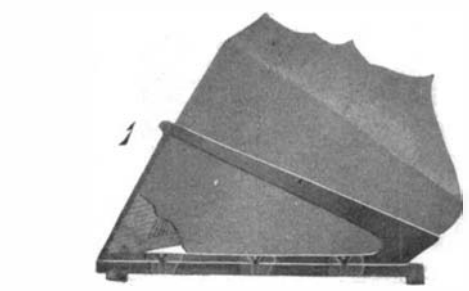
5. Electrodes placed on the head and anterior extremities caused very great disturbances, but when the current was broken respiration returned, and the heart started beating again.

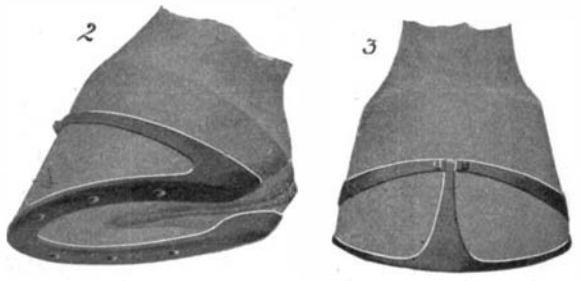
6. Electrodes placed on the two anterior extremities did no great damage.

Inference: These observations seemed to suggest a possible preventive measure for workers exposed to the danger of strong currents, viz., that they should wear a corset made of some non-conducting material, as rubber. This corset, to be of any value, must be closely applied to the skin and about the shoulders and base of the neck above, and to the lower portions of the trunk below; and opposite the heart region it should be separated from the skin by some non-conducting material, for example, India rubber. The corset should certainly not be separated from the body by any underwear.

A NAILLESS DEVICE FOR ATTACHING HORSESHOES.

It is well known that the common method of shoeing a horse by nailing on the shoe is not only primitive in the extreme, but also very injurious to the hoof. This is especially true of the thoroughbred horse, whose hoofs have a much thinner shell than have those of a coarser-bred animal. Furthermore, a racehorse must be shod with a special racing shoe before each race, and immediately after the race this shoe must be torn off and replaced with an exercising shoe. As a result of this constant changing of shoes, the hoofs are, in time, so badly torn as to seriously cripple the horse. To remedy these conditions, inventors have long been endeavoring to devise a horseshoe that could be applied without the use of nails; and while some very clever inventions have been made, most of them have been too complicated or expensive to compete with the common horseshoe. In the accompanying engraving we illustrate a very simple device for attaching shoes to horses' hoofs without the use of nails. This device, which is properly called a horseshoe carrier, is the extreme of simplicity, being stamped in a single piece out of mild sheet steel, one-eighth inch thick and bent to the required shape. It will be noted that the carrier is formed with a toe piece, and with two side bands extending forward from the heel ends of the device. These bands and the toe piece are joined by a bolt, thus firmly holding the carrier to the foot, because the hoof at the sole has a larger circumference than at the point where the bands encircle it, as best shown in Fig. 3. At the rear ends of the carrier, cups are formed to receive the heels of the hoof. These cups prevent the carrier from spreading open and slipping off the hoof.





A NAILLESS DEVICE FOR ATTACHING HORSESHOES.

This is a most valuable feature of the invention, for it obviates the necessity of binding the rear ends of the carrier together with a cross-bar, and thus avoids that circular constricting pressure which has been the chief failing of many previous inventions. It is claimed for the horseshoe carrier, that it will greatly reduce the cost of horseshoeing. The shoe proper is attached to the carrier as shown in Fig. 1, by means of screws or countersunk rivets, so that it can be removed from the carrier when worn out, and another shoe attached. Also this method greatly diminishes the difficulty of shoeing a restless horse, as, before applying it to the hoof, the shoe is first made fast to the carrier, and then the carrier with the shoe attached is put on in half a minute, and made fast by the turning of a single bolt. A shoe of paper, India rubber, leather, or any other material can be as easily attached to these carriers as an ordinary shoe. Patents on this nailless device for attaching horseshoes have been procured by Messrs. R. Hamilton Gibb and J. D. W. Elliott, of 541 Lexington Avenue, New York.

The Current Supplement.

The utilization of motor coaches upon British railroads over those sections of track which extend through sparsely populated districts is rapidly extending. One of the latest types of motor coaches to be thus used is a steam car, which is very thoroughly described in the opening article of the current SUPPLEMENT, No. 1561, by the English correspondent of the SCIENTIFIC AMERICAN. The Zoelly explosion gas turbine is described. The experiments of Prof. Scripture in phonetics are very carefully discussed, and painstakingly illustrated by elaborate diagrams. Alfred Ditté writes on the metals in the atmosphere. An excellent article by the late George M. Hopkins is presented on the demagnetization of watches. A Parisian firm has recently experimented with a new stern wheel for propelling motor boats designed for the rapid transportation of a small amount of freight at a small expense. This stern wheel is well described and illustrated. F. J. Aflalo gives a very interesting account of the wonders of a glass of madeira. How a thermostat for amateurs can be easily made is told by Edward F. Chandler. Many attempts have been made to obtain a rotary form of explosion motor, but none of them seem to have met with success. One of the more recent attempts in this direction is the new Primat motor, which is described by the Paris correspondent of the SCIENTIFIC AMERICAN. Brysson Cunningham writes exhaustively on mortars and cements.

Electrical Notes.

According to information which is obtained from St. Petersburg it appears that the question of the use of electricity for the Trans-Siberian railroad is being considered seriously. It is seen that it will soon be necessary to increase the number of trains to 40 or 50 per day. At present the speed of the trains, as is well known, is limited by the lightness of the rails, the defective profile of the track and the lack of water. Experts claim that these difficulties can be overcome by the construction of better tracks and the use of heavier locomotives having tenders of larger capacity. According to Count A. F. Zubienski, one of the best-known Russian electricians, there would be some economy in adopting electric traction on some sections of the line.

An extensive telephone system in Europe is to use the Pupin coil system. A telephone cable is to be laid across Lake Constance, according to a recent agreement between the bordering countries, Wurtemburg, Bavaria, and Switzerland. This cable, which is 9 miles long, has been ordered by the Wurtemburg Postal Administration from the Siemens-Halske firm of Berlin and the operation of laying it has already commenced. The cable has been provided with a system of coils on the Pupin (American) system. It is two inches in diameter and contains seven double conductors. Special precautions have been used to allow the cable to support the pressure which is found at the bottom of the lake, as this reaches 60 atmospheres.

Prof. J. Vanni, of the University of Rome, has made some researches upon a new standard cell for electrical measurements. This cell is of the Daniell type, in which a saturated solution of zinc chloride is substituted for the sulphate of zinc. He adopts the U-form proposed by Fleming, with a modification which he made several years ago, which consists in uniting the two upright tubes containing the solution by a tube of smaller diameter containing a glass stop-cock of large orifice. This is to be opened only during the measurements, and thus he avoids the disadvantage coming from the diffusion between the two liquids. The metals and the salts are as pure as possible. The positive electrode is a 0.2 inch covered with asphalt varnish and ending in a small horizontal disk of 0.4 inch diameter covered with electrolytic copper. A rod of distilled zinc amalgamated with pure mercury forms the negative electrode. After a number of measurements, he finds the electromotive force of the cell to be 1.24 volts at a temperature of 20 deg. C., in the case of saturated and freshly-prepared solutions.

Electric blasting methods for use in mining have been developed by a well-known Berlin firm. The advantage of the electrical method of ignition over the ordinary processes is quite evident. The moment of explosion may be controlled at will, and perfect safety is secured. The ignition chord, surrounded by the igniting powder, consists either of a wire brought to incandescence by the current or by a conductor with a break for the passage of a spark. The former alternative should be preferred as being more trustworthy, while dispensing with the use of the perfect insulation required in the case of the sparking method. As regards the source of current to be used in electrical blasting, galvanic batteries or else magneto-electric or dynamo-electrical machines should be employed. The blasting batteries are constructed according to the Meyer-Shamrock system and contain a number of Hellesen dry elements connected in series and a safety contact of a special construction to avoid an abusive use of the battery. Magneto-electrical machines should be used especially in case only a few shots are required, provided with a connecting switch inserting the circuit only after the armature has reached its proper speed, so as to avoid the risk of starting the more sensitive cartridges before others. In case a large number of blasts at some distance apart are to be operated simultaneously, the dynamo-electrical apparatus will be found most suitable. These consist of a small dynamo, the armature of which is driven by a strong spring wound up at any desired moment. When beginning operation, the whole crew having withdrawn and the circuit having been tested, the spring is disengaged by compressing a button. The armature now begins rotating, the field magnets being excited up to saturation and the electromotive force of the machine reaching a maximum. At this moment, the machine is switched over automatically to the circuit and all the blasts are ignited simultaneously.

Correspondence.

Construction of the Panama Canal.

To the Editor of the SCIENTIFIC AMERICAN:

As a subscriber of many years to your paper (through our local dealers) I take a deep interest in the Panama Canal. In offering the following plan to lessen its cost, shorten the time for its completion, and simplify its sanitation, I hope that I will not be considered presumptuous. Make the excavation from both termini on the sea-level plan. The canal itself to furnish all the transportation for the excavated material by means of flatboats or lighters. These as fast as loaded to be towed either to the jetties or to be dumped out into the deep sea. The work to be pushed as rapidly as possible to connect the two seas without regard to the width or depth, in order to obtain the scouring benefit of the rushing tides. Drain all intersecting streams into the canal. Slide or tumble the sand and rocks into the boats. Waste no time upon technical measurements, amount of rainfall, or the disposition of the overflow of the Chagres River. They can await a more opportune time. B. S. P.

Savannah, Ga.

Changes in Glass in High Altitudes.

To the Editor of the SCIENTIFIC AMERICAN:

In the Science Notes in a recent number of the SCIENTIFIC AMERICAN, reference was made to some experiments upon the changes in the color of glass caused by subjecting it to the ultra-violet rays of the spectrum. The statements there contained bring to my mind a phenomenon sometimes observed upon very high mountains, where old glass from bottles, presumably originally green, after exposure to the light of a great elevation in the regions of perpetual snow attains a beautiful pale purple tint. A number of specimens from Mount Ranier or Mount Hood may be seen, I think, in the museum of the Natural History Society in Portland, Oregon.

The same interesting results may also be observed in connection with the glass insulators used on telegraph or telephone lines in mountain districts. During a period of years I have found it very interesting to watch the changes in hue of the insulators on the telephone line connecting Laggan Station of the Canadian Pacific Railway with the Châlet at Lake Louise. The elevation is between 5,000 and 6,000 feet; and while the line runs through the forest almost all the way, the actinic effect of the light has changed the green glass of those insulators that have been up for several years to a brilliant purple. Those that have been in service longest apparently have the deepest tint. GEORGE VAUX, JR.

Philadelphia, November 20.

Engineering Notes.

The early boilers in sea-going vessels were of what has been called the "box" type; that is, the boiler was a cubical box with a thin shell, the real strength being given by braces running in three directions. When the surface condenser had made higher pressures possible, it was soon found that the multiplicity of braces, as pressures were increased, made an impossible condition of affairs, and this led to the design of the cylindrical boiler whose shell was self-bracing and left the only braces those needed for the heads and flat surfaces. This boiler so thoroughly met the conditions arising that it has remained the favorite even up to the present day. At one time an effort was made to save room by making the boiler elliptical, but this was soon found to be unsatisfactory and impracticable, and was abandoned after only a few examples.

It has been for some time a question in France as to how the main lines of railroad were to join on to the Simplon route. This question has been set back for a long time, mainly owing to political reasons, but there seems no doubt that the new trunk line will be constructed in the near future. The route which is proposed is to pass from Lous-le-Sannier to Geneva and it will be necessary to run a long tunnel through the mountain known as La Faucille. This will give a much shorter and better route from Paris through Switzerland than at present. The solution adopted by the French government is the one which has been already favored by the Paris-Lyons-Mediterranean Railroad Company and also by the city of Geneva. The cost of the work will be some $24,000,000, of which the railroad company will give $6,000,000, the Swiss government $2,000,000, and the French government the remainder.

The first wind- and water-mills were introduced into France, Holland, and England some time during the twelfth century. The first saw-mill in England was erected by a Dutchman in 1633; the spinning-wheel was invented, 1530; the diving bell, 1538; and great improvements were made in ships during Elizabeth's reign. Numerous canals were dug in all these countries. The New River was ditched to London, a distance of 60 miles, in 1608-13. This copious supply of water gave rise in England to fire insurance companies and to an organized fire department which was paid by the companies. The canal which connected the Loire and Seine was begun in 1605, and completed in 1640. Two thousand square miles of swamp lands were drained in Lincolnshire, etc., 1629-52. Tramways were invented at Newcastle in 1602. The steam engine was invented by Blasco de Garay of Barcelona, 1543; an armored paddle-wheel vessel, moved by crank and hand power, was employed, 1574, in the relief of Leyden (Motley); the experiments of Giambattista della Porta were made in 1601; of Solomon de Caus, a Frenchman, 1615; a wheel driven by steam was exhibited by Branca, an Italian engineer, 1629; the Marquis of Worcester's steam engine was seen in motion by the Grand Duke of Tuscany at Vauxhall in 1656, and is described by the Marquis in his "Century of Inventions," 1663; Gilbert produced frictional electricity in 1600; Schwenger, a German, planned an electrical machine, 1636; and Otto von Guericke constructed one in 1647. Coach is an Hungarian word, meaning a covered carriage suspended on straps. In modern times coaches and carriages were first constructed in France, 1547; and England, 1555. In 1619 the Duke of Buckingham drove six horses in a carriage, and in 1620 the Duke of Northumberland drove eight. Carriages were first let for hire in Paris at the Hotel Fiacre, whence the name of fiacre, in 1650. In 1550 there were only three pleasure carriages in Paris; in 1580 only two in England. Turnpike gates were introduced in 1663.—Delmar's "History of Monetary Systems."

LABOR-SAVING DEVICES UTILIZED IN THE MANUFACTURE OF TEA.

BY C. SMITH.

The rapid development that has been made during the last decade in labor-saving devices and their introduction in the Far East made it inevitable that the old, cumbersome, and primitive methods used in the manufacture of tea would be superseded by western ideas and modern machinery. Coolie labor is no longer essential to the extent it has been in the past, and the modern methods are not only more economical and quicker but also more sanitary, the hand and foot of the coolie being happily eliminated from the work.

The leaves of the tea plant are picked and gathered by the coolies and brought in baskets to the factory in a crisp and brittle condition. Here they are first carefully weighed and then spread out on racks or shelves in what are known as the "withering lofts" until they become soft and limp. It is a recognized fact that a good wither is essential to the manufacture of high-class teas, but, owing to climatic conditions, this process has presented one of the most serious obstacles with which planters have had to contend. The modern method of tea withering, however, is entirely independent of any such atmospheric influence. Fans specially constructed for the purpose are employed to control the air in the withering lofts and direct it over the leaves as they lie spread out on the shelves, the exact arrangement of the apparatus depending on the factory in question. The time which is required depends on the quality of the leaf, the extent of its saturation, the amount of heat and moisture in the currents of air passing through the lofts, and the state of the outside atmosphere. Under the most favorable conditions a good cold limp wither can be produced in six hours, but ordinarily twelve hours are necessary for the process. Formerly forty-eight to sixty hours were required, or even more when the air was exceptionally moist. The tea leaves are left in the withering loft until they are limp enough to be twisted without breaking, when they are put into the rolling machine. This machine, which can be seen in Fig. 1, has a capacity of 300 to 350 pounds of withered leaf and does the work which formerly required about 100 coolies. One attendant is necessary to operate it, and when working with a full charge of 350 pounds it requires but 2 horse-power. The object is to break up the cells of the leaf prior to fermentation. The table under the hopper of this labor-saving device is fitted with "plows" and a cone-shaped projection which subject the leaves to a very strong lateral pressure and impart such a motion to the center of the mass that each leaf receives a remarkably equal and well-twisted rolling, while at the same time the entire mass is kept completely aerated and cooled. About half-an-hour is usually sufficient to effect the rolling operation of 350 pounds of the withered leaf. The tea is discharged by opening the door of the leaf chamber while the machine is running, the rolling table automatically ejecting the tea onto the discharge shelf in front. Any leaf or juice which escapes through the clearance space between the lower edge of the leaf chamber and the upper surface of the rolling table is automatically swept around to a delivery spout on the table where it can be gathered and replaced in the leaf receptacle. The speed and economy with which this type of machine does its work are especially noteworthy when compared to the primitive methods formerly employed for this purpose.

The wet roll, as the leaf is now called, next passes through a rotary sieve which sorts and cools it, at the same time breaking up any lumps there may be in it. The leaf as it comes from the rolling machine is emptied into the bin or hopper on top of this machine and is drawn forward by rakes into a chute which delivers it directly into a sorting cylinder. The cylinder is fitted with screw adjustment for raising and lowering the angle at which it works so as to give a quick or slow passage to the leaf. It also has wire webbing of two sizes of mesh which separate the fully rolled and fine from the medium-sized leaf, the coarse leaf being thrown out at the lower end of the cylinder so that it can be further rolled. In this way each of the three classes can be fermented separately and the best results thus obtained, as the finest qualities, which always ferment most rapidly, can, when thus separated, be dried off as soon as they have fermented sufficiently without waiting until the coarse, which requires a much longer time, is ready.

The most important feature of the manufacture of tea is the drying process to which the leaf is now subjected. For this work drying machines are used, their capacity ranging from 40 pounds to 350 pounds of fully dried tea per hour. There are two distinct forms of machines in use, known respectively as the "updraft" and "downdraft" types.

The former type of drier, as its name indicates, works with a self-acting upward current of heated air which passes up and through the drying chamber containing the trays of tea. The temperature and strength of the air current are controlled by valves fitted in the air-duct above the trays. There are also two distinct types of updraft driers, the side-drawer and the end-slide forms, depending on the position of the drying chamber. In the latter machines the trays are inserted at one end of the machine while in the former type they are placed at the side of the machines. In all updraft machines, however, the same method of working the trays is employed, the trays with wet roll being first inserted into the drying chamber through the top slide and then in rotation into each of the lower slides, the drying process being completed in the bottom slides, where the trays are finally withdrawn and then reinserted at the top with a fresh charge.

In the downdraft drying machines the hot air passes down instead of up and over the trays holding the wet roll, a centrifugal fan being used to obtain the downward draft. The trays are placed in the bottom tray port and slowly raised by means of levers till they reach the top, when they are withdrawn, the tea being by then thoroughly dried. A coolie attendant is necessary to withdraw and insert the trays. In the downdraft drier, seen in Fig. 4, there are two drying chambers, each fitted with ten trays and having a total output of 320 pounds of dried tea per hour, a temperature of 220 to 230 deg. being maintained. The fans in this machine are driven at a speed of 400 revolutions per minute and require 1.5 horse-power each.

A newer and more improved type of machine has recently been designed with a capacity of 350 pounds of fully dried tea per hour. In this machine the leaves are automatically discharged when they are thoroughly dried, one coolie being required to feed the leaves into the trays. Special attention has to be paid in these machines to efficiency and economy in working as well as to rapidity of operation. Various classes of fuel are used in all driers, the particular kind depending on the price in that particular vicinity.

Of late considerable attention has been paid both in Ceylon and India to the manufacture of green tea to supply the demands of the western trade, and this has led to the requirement of a machine to glaze or polish the tea in large quantities after it has been dried. The glazing machine consists of a vertical-flue air-heater, so connected to a large revolving drum that a self-operating continuous flow of hot air enters same. The drum is driven by belt through a very simple arrangement of worm gearing. The tea is carried round in the drum by a series of ledges fastened to its inner circumference, and falls in a continuous stream over the central baffles, below which the hot air enters the drum. The tea which is thus subjected to a constant rubbing action under the influence of air at a high temperature gradually attains a grayish green bloom which is characteristic of the best qualities of green tea. It is not known what chemical effect takes place in the tea during the glazing process, but it is undoubtedly the case that the tea thus treated has better keeping qualities, and gives, when infused, a more pungent liquor than prior to this operation. The hot air escapes from the drum at the opposite end to that at which it enters, and the volume allowed to escape is regulated by means of a valve in the outlet pipe so that any temperature can be maintained in the drum from 180 to 240 deg., the latter temperature being the proper one for the glazing. Two doors are provided in the drum, through which the charge of tea is inserted, and when the glazing process is completed, the drum is stopped and the doors taken off, and when the machine is then started the tea is automatically dis-

charged. The drum is 8 feet in diameter and revolves at a speed of five to six revolutions per minute, taking a charge of 600 pounds of fully dried uncut tea, or 1,000 pounds if cut and sifted beforehand. One and a half to two hours are required to complete the glazing at a temperature of 240 deg. F.

Tea cutting machines are also extensively used on tea plants and consist of a fluted cutting roller with resistance plate and side brackets mounted on a stand with a receiving bin for the tea. The tea is next sorted into the various grades by a tea sorting machine, one of which is seen in operation in Fig. 5. This sorter is similar in many respects to the one previously mentioned, the tea being delivered by the chute to a large revolving cylinder having five sizes of wire mesh for separating the tea into five different grades. This machine can efficiently sort 800 pounds of tea per hour.

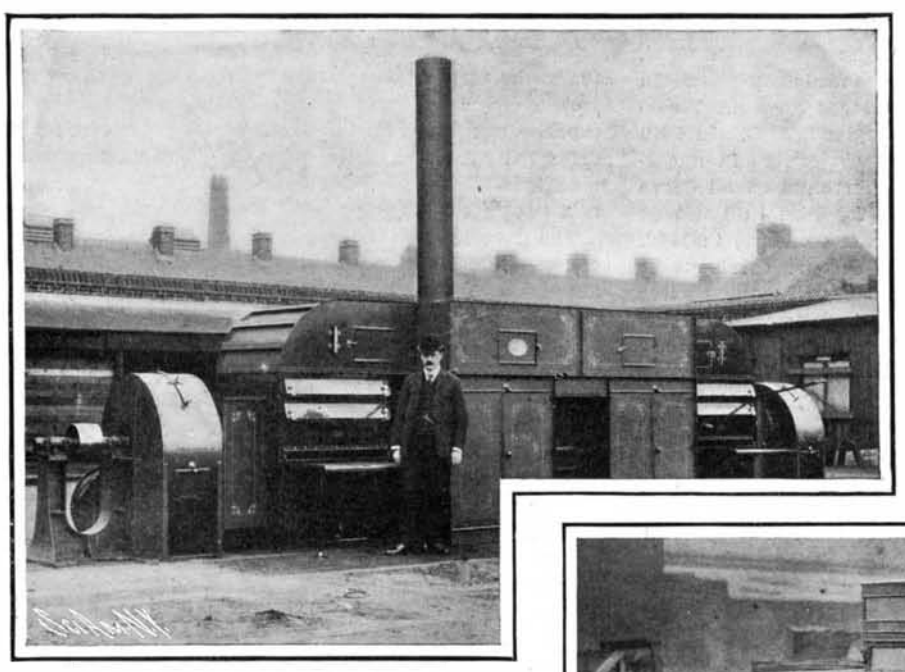


Fig. 4.—Large Down-draft Drier.

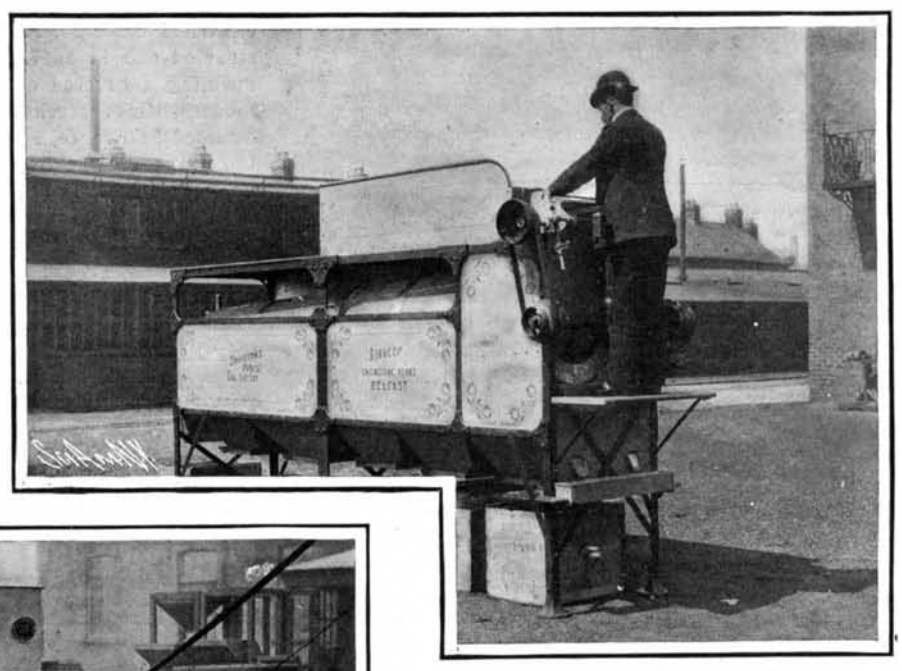


Fig. 5.—Automatic Tea Sorter.

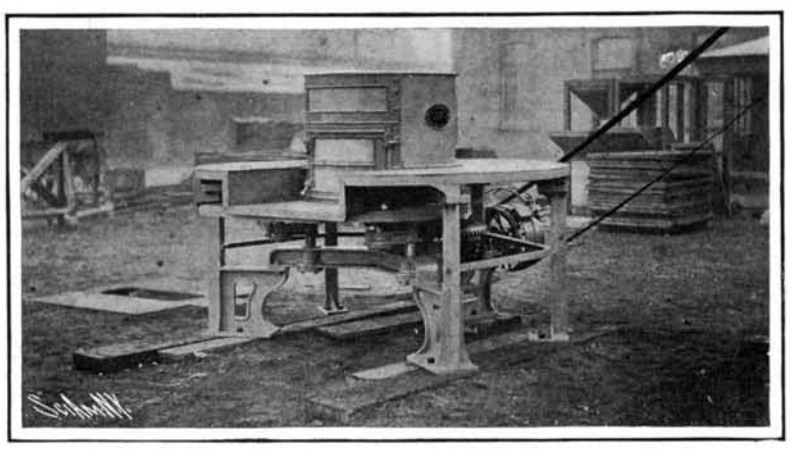


Fig. 1.—A Tea Roller.

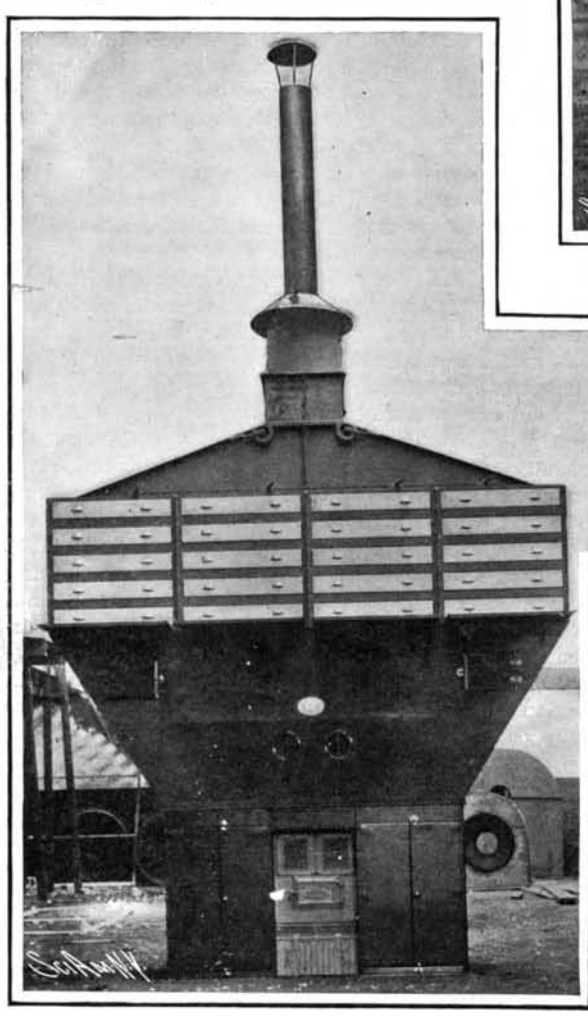


Fig. 2.—20-Tray Up-draft Side-Drawer Multitubular Air Heater.

Fig. 6.—A Tea Packer.

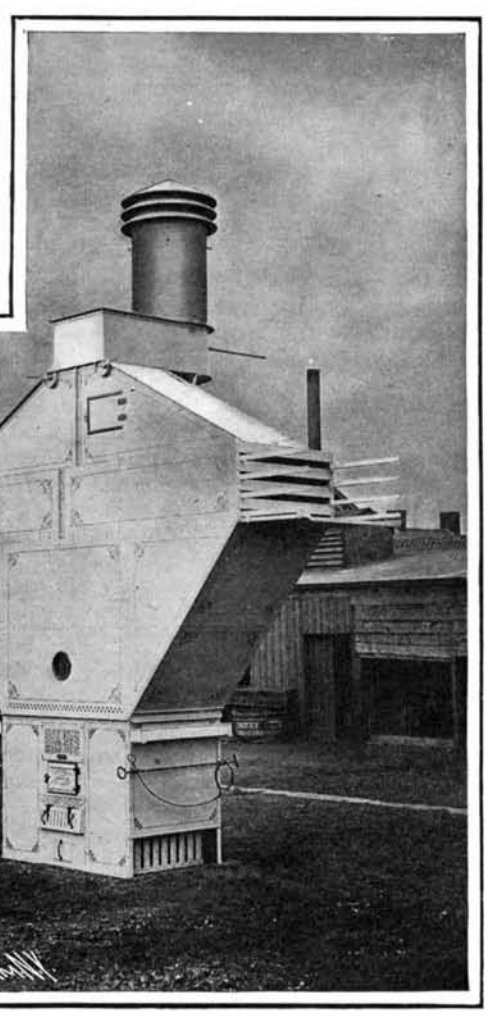


Fig. 3.—16-Tray End-Slide Up-draft Vertical-Flue Air Heater.

LABOR-SAVING DEVICES UTILIZED IN THE MANUFACTURE OF TEA.

The tea is then ready to be packed and is put into chests which are placed on the "tea packer."

This machine (Fig. 6), which is one of the most interesting labor-saving devices utilized in the manufacture of tea, consists of a rocking table, fitted with clamps and screw-tightening gear for gripping the chests, and connected to a phosphor-bronze eccentric by a steel shaft. The eccentric is mounted on a steel shaft which runs at a speed of 1,000 revolutions per minute and is supported in bearings of large proportions to withstand the vibratory action of the eccentric. The particles of tea, under the influence of this vibratory motion, settle down closely and compactly in the chests, which are filled very rapidly, one machine being able to pack 20 to 25 chests per hour. Moreover, by the use of a packer the tea is neither crushed nor broken, and from 5 to 8 per cent more can be packed into each box than by any method of hand packing. Until the recent introduction of machines of this type the tea was, it is stated, frequently packed into the chests by coolies tramping it down with their bare feet, a knowledge of which would probably have lessened the æsthetic joys of tea lovers.

The writer is indebted to Messrs. Davidson & Co., Ltd., of Belfast, Ireland, and to their American representatives, the Sicocco Engineering Company, of New York, for the accompanying illustrations, this firm being the pioneers in this particular field.

THE EARTH PYRAMIDS OF THE TYROL.

BY W. G. FITZ-GERALD.

Specimens of "earth pillars," due to the action of wind and rain, are seen in a more or less rudimentary form in many countries, including our own; but to behold them in all their fantastic impressiveness—as it were in groves, or forests—one must visit certain parts of Switzerland, and more particularly the Austrian Tyrol. By far the most important group are those known as the earth pyramids or stone-capped pillars of Botzen, for whose formation every circumstance has been favorable, as we shall see. They are what the physical geographers would call "columns of indurated mud," from twenty to a hundred feet high, and usually capped in a very curious manner by a huge stone. They have been hewn, as it were, by the rain out of the terrace they once formed part of, and now stand in groups on ledges and steep slopes bounding the narrow valleys.

That most picturesque Tyrolese town of Botzen is situated on the Eisach, a couple of miles above the junction of that river with the Adige; and it is only a short distance above the town that the principal groups of earth-pyramids are situated. The first group one comes upon, nearest to Botzen, is that in the ravine of Katzenbach, about 1,700 feet above the town. Most remarkable are three pillars for their number, size, and beauty. There are other groups found in the ravine of the Finsterbach near Klobenstein, 2,200 feet above Botzen. But indeed the whole valley of the Finsterbach River is decorated with these fantastic pillars, which the action of hot sun and rain have hewn out of the precipitous banks which hem in the river. The average breadth of the Finsterbach valley is only 600 or 700 feet, and it is from 400 to 500 feet in depth.

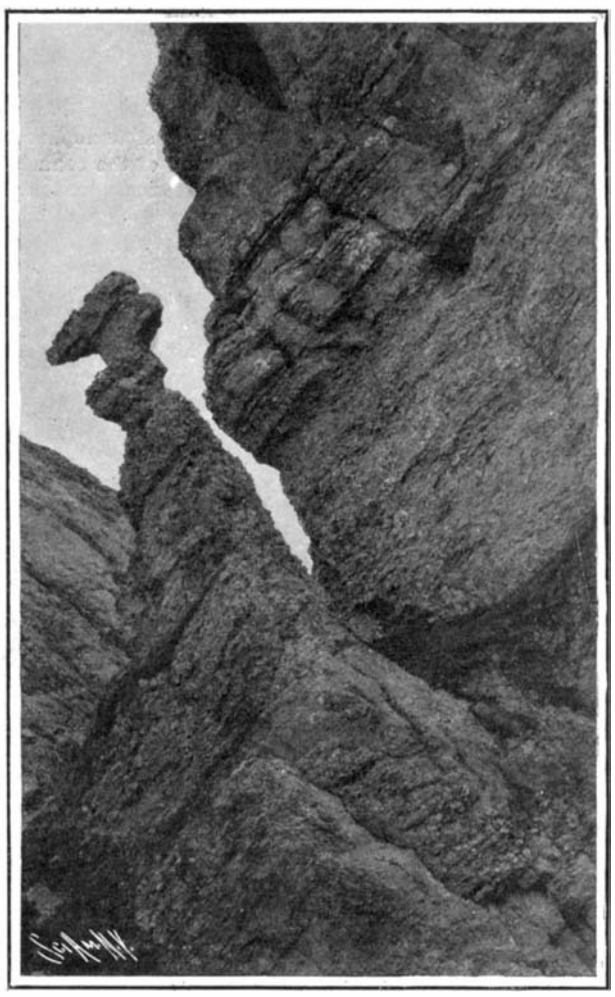
The lower part of each of these columns usually has several flat sides, so that it forms a pyramid rather than a cone. Close examination shows that the columns are composed of red unstratified mud of an extremely hard kind, curiously mixed up with pebbles. Up and down through the pyramids are scattered angular pieces of stone, many of them of a very large size; and as we shall see presently, a stone which may be twenty or thirty feet from the top of the pillar may one day be at the extreme summit, sheltering the column from the torrential rain. In fact the whole mass of which these pyramids are composed answers to the moraine or debris left by a moving glacier. Indeed, some of the masses of rock imbedded in them have their faces smoothed or polished, furrowed or scratched, clearly revealing their glacial origin. The chief reason why these are the most remarkable earth pyramids in the world is found in their

composition. The whole country round about appears to be composed of red porphyry; and the most numerous and biggest of the stones that protect the summits of these pillars are composed of this same red rock.

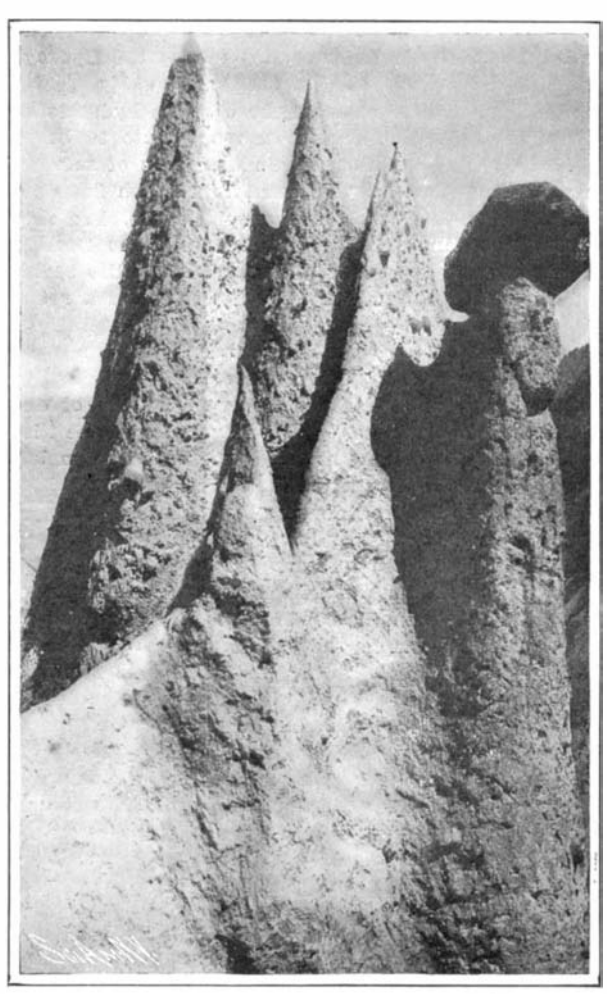
Now to explain the origin of these strange-looking pillars. First of all the Finsterbach River has in the course of ages dug out its channel at great depth, until it excavated a valley in a country of red porphyry rock. Next this valley was filled up in its lower part by débris and moraine matter, probably left by some great river of ice, after it retreated up the valley at the end of the glacial epoch. Then came the river again to hew and carve a chasm out of the moraine, whose red, mortar-like mud in due time presented a precipitous and perpendicular face to the river. This mud, extremely hard and solid as rock, almost, when dry, is in due time drenched by rain and then scorched by the sun—a treatment which causes great vertical cracks, into which the heavy rain beats again and again, and so the pyramids are isolated and gradually made to stand out in solitary majesty. Those parts of the surface that are protected from the direct downward action of the rain by means of a big stone occurring in the mud, are the ones that make the most successful pyramids. If the stone be not big, however, the rain beating sideways wears out the "neck" of the pyramid, and the stone in time falls off, leaving the column terminating in a sharp point. But if, on the other hand, it be very large—several yards in diameter, as many of them are—the top remains secure, and the downward action of the rain ever lengthening the column, causes it to grow and grow until it often exceeds a hundred feet in height. Round about the pillars one may see huge fallen blocks which once were the "cappings" of other columns and pyramids which have now disappeared, or, having lost their protecting stone, have grown smaller and smaller beneath the pitiless rain. The lower parts of some of the more ancient columns still exist, because in decreasing in height they have suddenly acquired new capping-stones which have been brought to the surface by the action of the rain. Here and there one may see imbedded in a terrace a great mass of porphyry rock with cracks around and above it, and here one recognizes the stone-capped pyramid of future years.

Both in the main valley and in its tributaries the columns and pillars are arranged in rows, which descend from the edge of the terrace to the picturesque torrent itself. Intervals between the groups are often filled in with fir trees, which form an extremely picturesque background. The spaces occupied by these firs were probably once filled in with "groves" of earth-pyramids, long since undermined and swept away by floods. Some years ago in cutting a road near a bridge over the Finsterbach River, the water collected during heavy rain-storms and scooped out a small channel which in a few years undermined and destroyed no less than twenty of the most stately pillars and columns. It may be asked why these earth pyramids are so very rare. Rudimentary pillars are found in many parts of the Alps, as well as in Scotland, Norway and Sweden, and in many parts of America. But it is only near Botzen, where the red porphyry mud and rock are found, that these earth pyramids, of a solid homogeneous nature, weather with vertical faces possessing every requisite for making successful, lofty, and long-enduring columns.

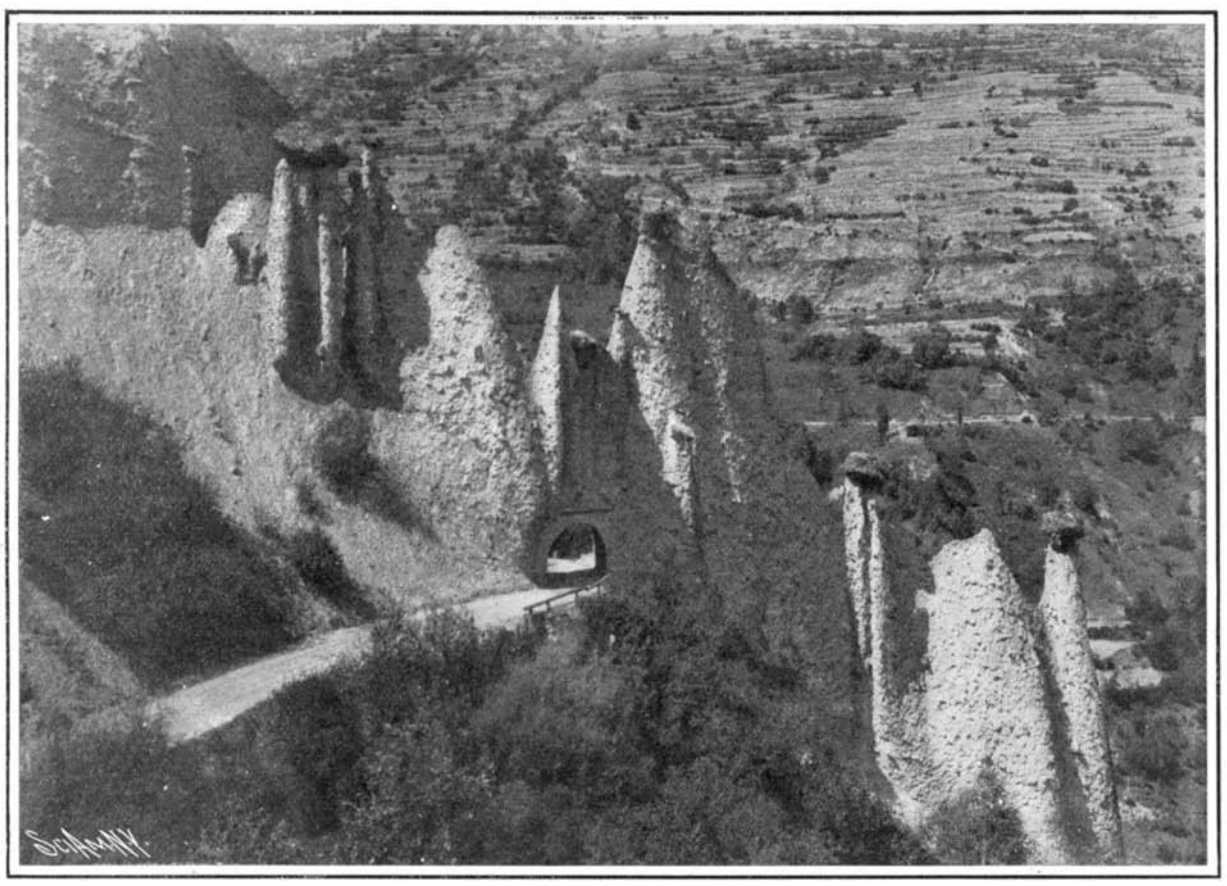
Stone Sheltering a Group of Pyramids From the Rain.



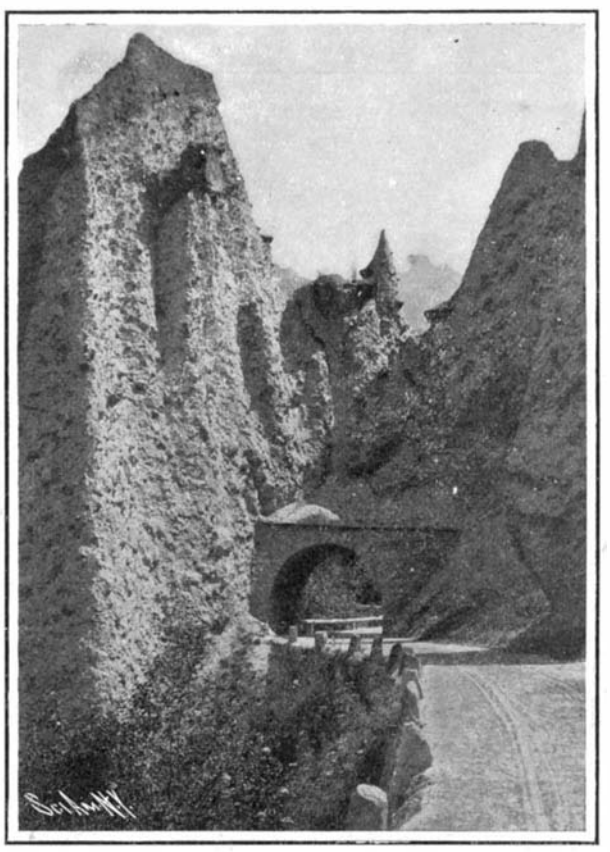
The "Duck's Head" Rock. All of Rock; the Earth Has Been Washed Away by Rain.



Pyramids That Have Lost Their Capping Stones.



Looking Down Into the Valley From the First Group of Pyramids.



The Road From Botzen Running Through the Forest of Earth Pyramids.

THE EARTH PYRAMIDS OF THE TYROL.

The railway companies of England and Wales employ between them 312,000 men. The Scottish and Irish companies employ 40,000 men between them.

COMPOSITE ANIMALS.

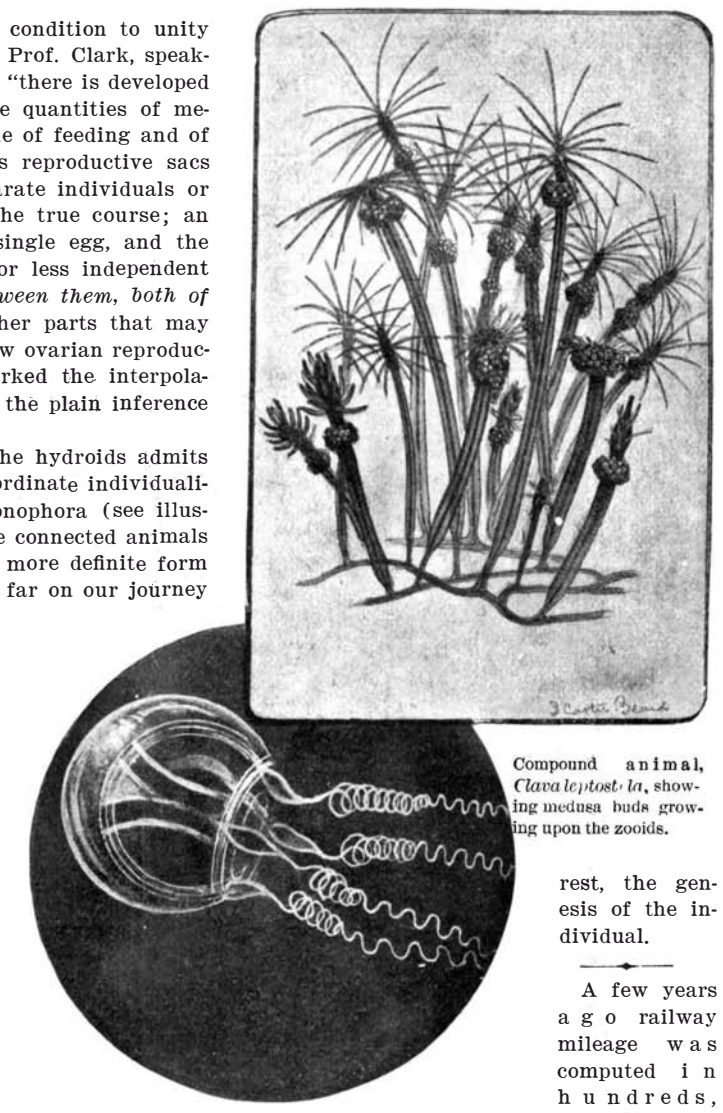
BY J. CARTER BEARD.

The circle of individuality, which beginning with that simplest of units of living matter, the free cell, ascends in a spiral, and returning upon itself finds expression in the higher unities of multicellular organisms, of which the original cells are integral parts, thus forming a second and more perfect set of individualities, makes or tends to make another complete circuit, in producing, by the aggregation of this second set, still a third series of individualities.

Carried through an increasingly intimate association in forms and functions of life, among the so-called compound animals, especially the ascidians, the third circle is still left incomplete, and the missing arc is perhaps more nearly supplied by the *Hydrogia* than by any other class of animals.

When it first issues from the egg, the hydroids are little flat wormlike creatures, too minute to be examined by the naked eye. Under a lens of sufficient magnifying power they appear fringed with fine hairs or cilia, by means of which they swim about. In a short time this planula, as it is called, attaches itself to some support, and the second stage of its life begins. It loses its cilia, and assumes the shape of a round-bottomed flask. It changes its form several times, and at last is elongated into a stalk, sends out roots, and at the summit blossoms into a flower-like circle of tentacles. The tentacles elongate, clusters of eggs like fruit appear (see figure of hydroids in the illustration, No. 2) and the life circle seems to be complete. From the roots other individuals arise, some of which, like the parent form, develop hydranths or blossoms, but others, instead of so doing, have only reproductive functions. In these last are developed small zooids, which in some cases become free, and in other cases, as for instance in the species figured in the illustration, *Clava leptostyla*, they never separate from their parent. The medusa-buds produce eggs and spermatozoa, which in turn give rise to other colonies similar to that described. Here is exhibited a division of function among the individuals forming the colony, which in fact in its entirety is a single animal, which is not to be found among the compound ascidians. The hydranths or individuals carrying tentacles are the nutritive portions of the colony. The tentacles capture, and the stalk digests food for the whole organism, while the gonangia devote themselves to reproducing offspring. Full of suggestion and interest as it is, only the hastiest glance can be given to this branch of the subject. The only remark which the present opportunity allows with regard to it is that, strange as it appears, it nevertheless seems to be shown in the genesis of hydroid communities that an animal can exist in separate parts, and that a continuity of substance is not an indispensable condition to unity of individuality. "From a single egg," says Prof. Clark, speaking of the matter from a different standpoint, "there is developed a number of zooids, from which there escape quantities of medusæ (jelly fish) which are frequently capable of feeding and of reproduction. Are each of these jelly fishes reproductive sacs and feeding portions, to be regarded as separate individuals or as parts of one individual? The latter is the true course; an individual embraces all the products of a single egg, and the name zooid is applied to the various more or less independent portions, *whatever spaces may intervene between them, both of the medusa buds that float away*, and of other parts that may arise by dividing or fission, but never by a new ovarian reproduction." The writer has interpolated and marked the interpolation in this paragraph, in order to carry out the plain inference given by the statement.

But after all, the division of function in the hydroids admits of little diversity of component zooids or subordinate individualities, while in the colonial jelly fish or siphonophora (see illustration) the specialization of offices and of the connected animals which perform them, as well as in the much more definite form and character of the aggregate, bring us very far on our journey toward realizing that a composite animal of the third degree, consisting of the union of complex individuals, may yet have an individuality of its own quite apart from those of the members which compose it. The composite animals belonging to this class consist of communities of individuals, each and all of which are modified and specialized in such a manner as will most effectually serve the communal body to which they are attached. This body, instead of consisting of a fixed and stationary colony of zooids, whose boundaries are shaped and determined by the spot it chances to occupy, has like the higher animals a constant form peculiar to its species, is free, and has the means and power of voluntary motion.

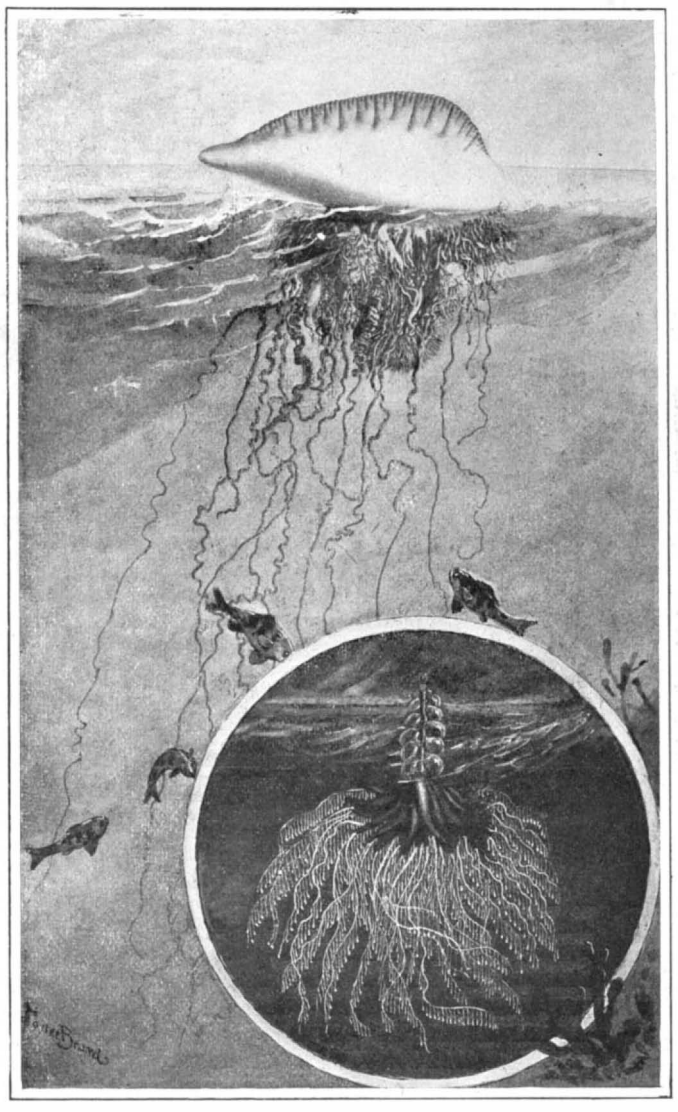


Compound animal, *Clava leptostyla*, showing medusa buds growing upon the zooids.

Medusa of Campanularian hydroid.

COMPOSITE ANIMALS.

The *Physalia arethusa*, for instance, consists of a large elongated air sac or float, surmounted by an elegant indented crest, which is nothing else than a zooid enlarged and adapted for the purpose it serves, and a multitude of animals of different degrees of development according to their use, clustered upon its under part toward the broader end. These pendent animals have surrendered the power of separate existence, and so much of individuality as to become little more than the organs of the corporate body. A portion in which all functions have become atrophied except that of progressing through the water, by allowing it to enter their cavities and then forcing it out again, constitute the locomotive organs of the physalia. Other hollow structures open at the end are so many mouths with stomachs attached; they seize upon all such tiny marine organisms as certain other members of the community, modified into long processes armed with stinging and paralyzing organs, shock into insensibility. They devour and digest the food thus provided, and send the nutritive fluid that they elaborate to all parts of the colony. Scattered among these feeding stinging polyps are smaller zooids with egg-shaped bodies, each carrying a long thread. These threads are really nerves, and are very sensitive. Their use is to make the organism to which they belong aware of its surroundings. They are sense organs. Besides these there are two or three other sorts of individuals, which elaborate the particular sort of reproductive cells required for the perpetuation of the particular species to which the composite animal belongs. These are specialized medusa polyps, of which one sort larger than the other supplies the active sperm cells, while the smaller sort furnishes the inactive egg cells.



Physalia arethusa—American Portuguese man-of-war, or jelly fish.

Physophora hydrostatica—Mediterranean jelly fish.

COMPOSITE ANIMALS.

This is certainly a remarkable state of affairs, however we may consider it. If the various parts and the different organs of our bodies, the lungs, the stomach, the nerves, and all the viscera and members of our bodies, were individual entities that might be conceived of as originally separate organisms, each part still possessing in some sort traces of a separate consciousness of its own, it could scarcely be stranger. There are many of these composite animals, presenting every degree and variety of complexity, until we reach those in which the individuality of the constituent parts is entirely lost.

And thus a circle in life of which only the roughest sketch can be here suggested (it would require a volume to do it justice) as far as our space allows, is completed.

It is certainly a wonderful and a suggestive circle, one that might possibly have a value and a meaning not only in any given theory of genesis of species, but upon the foundation upon which all such theories must rest, the genesis of the individual.

A few years ago railway mileage was computed in hundreds, whereas now it is measured in tens of thousands. The general manager once knew all of his subordinate officials, because they were few and changes were not frequent. He once knew all of his master mechanics, station agents, conductors, engineers, dispatchers, and even telegraph operators. They knew him and were working for him because he was personally close to them in their work. All this has changed as the roads themselves became greater and as roads, great in themselves, combined into systems, as has never been done anywhere else in the world. With this change the officers have, by a powerful current, been carried far from the men in the ranks and far even from their subordinate officials. From personal friends, the men have become to them as mere numbers.

THE PERGAMON MARBLES IN THE PERGAMON MUSEUM OF BERLIN.

BY CHARLES A. BRASSLER.

When, in 1873, the German savant, Carl Humann, sent the first pieces from the Pergamon citadel to Berlin, no one would have thought that they might some day give impulse to the construction of the museum which is now standing on the Museum Island in Berlin.

The discovery and the excavation of the Pergamon antiquities has been, for men of art and science, an event of extraordinary importance. It is true that before the German discoveries were made, Pergamon, now Bergama, and its citadel had been visited several times by savants, especially of France, who after their visit reported that, in all probability, antiquities of undreamt-of importance might be hidden beneath the débris and rubbish of the acropolis. But the credit for having discovered these antiquities is due in the first place to Carl Humann, and then to Alexander Couze, at that time director of the collection of antique sculpture in the Royal Museum, who, when seeing the first pieces of the great frieze, recognized them as parts of the "Gigantomachie" mentioned by Ampelius in the words: *Ara marmorea magna, alta pedes quadraginta, cum maximis sculpturis—continet autem gigantomachiam.*

Excavations, conducted by Humann under the direction of the Royal Museum were made from 1878 to 1886. Later they were again and again prosecuted, and recently the German Institute of Archæology has continued and extended them over the entire site of the old capital. They have revealed a complete picture of the old royal citadel of the Attalides and of its aspect in the time of Roman kings and, above all, they have restored a unique work of art—the reconstructed great altar with its frieze. It was not before the Pergamon antiquities were discovered that the connection of Greek and Roman art was established. It is also for this reason that the Pergamon discoveries have been an event of extraordinary importance.

These relics are now preserved in the Pergamon

Athena and Her Adversaries.

Museum of Berlin. On the walls and stands of the vestibule pictures and plans are exhibited to make clear the environs and the relations of the Pergamon monuments to one another. Within the museum itself, undoubtedly the most striking object is the Great Altar. In all probability this altar, which stood in the middle of the older town on the acropolis of Pergamon, was built by Eumenes II. (197 to 159 B. C.) and dedicated to Zeus and Athena.

The sacrificial altar proper stood on the platform of a quadrangular substructure about thirty meters square, through which the broad stairway led to the sacred level. The frieze or high relief of the great altar ran around this substructure and along the wings of the stairway at a comparatively low altitude (the base is 2.5 meters high). At the top of the frieze a bold cornice with wide moldings projected from the platform. Above this quadrangular structure ran a colonnade of delicate Ionic columns, open like a portico on the outside and closed at the back. The court, or room formed by its inclosing wall, contained the sacrificial altar, and was ornamented on the inside by a smaller frieze. The extant fragments of this second frieze representing scenes from the life of Telephos, the mythical founder of Pergamon, are set up in the museum opposite the west side of the Great Altar.

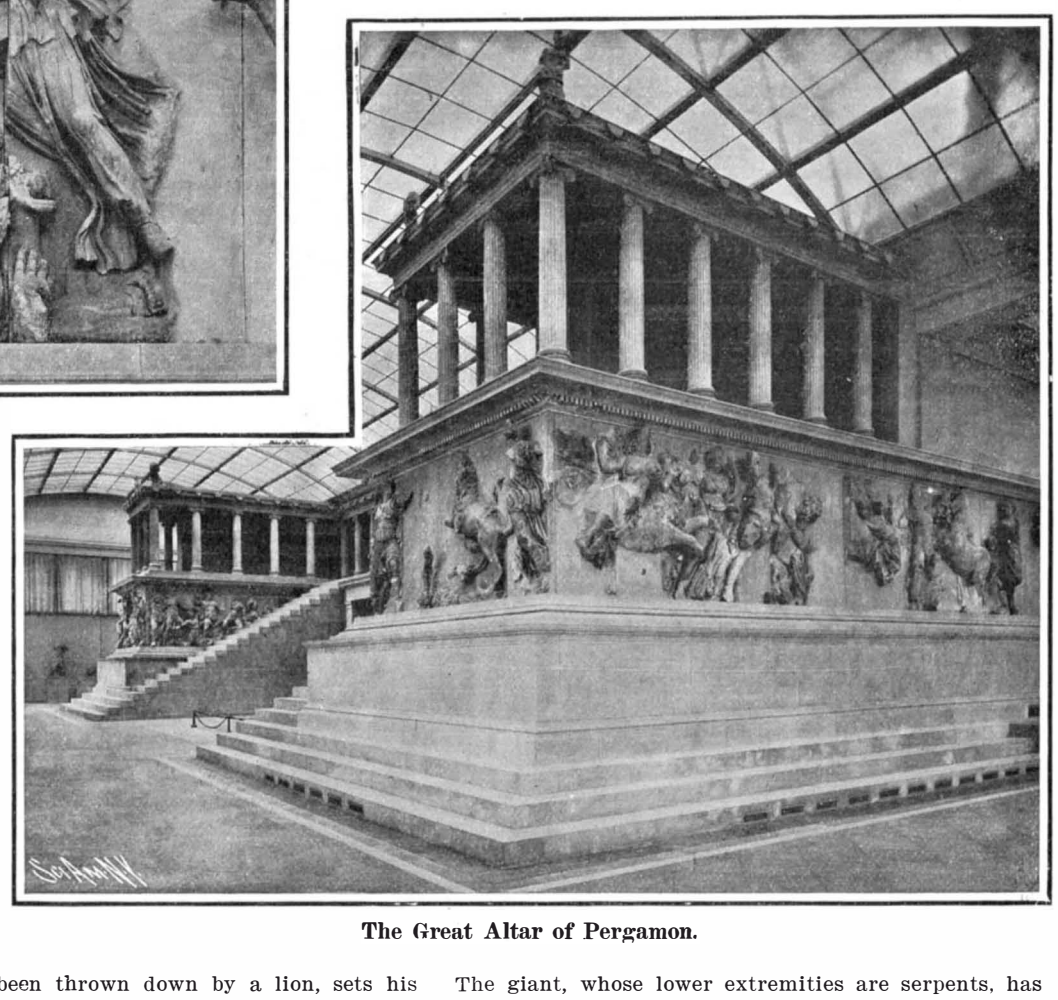
The colonnade which encircled the platform is represented on the west side only, but the base, the frieze, and the cornice are given by reconstruction and restoration all the way around. Parts of the original base and colonnade are built into the altar, to the left of the stairs. The great frieze, as a whole, represented the battle of the gods and the giants; the incised names aided in understanding the individual figures.

On the left corner of the smaller right part of the west side of the altar we see the ivy-crowned Dionysos accompanied by his panther. The god wears a short, full garment with the skin of an animal girded above. He strides rapidly forward, and lifts his right arm to strike a blow. At his side hurry two boyish satyrs, not to be seen on this picture. The antagonist of Dionysos is lost. There is also missing the upper part of the body of a giant who, as the following slab shows, having been thrown down by a lion, sets his left foot against the animal's flank.

The advancing female figure, back of the lion, with a high crown-like ornament and olive wreath on her much-mutilated head, is probably Rhea, the mother of Zeus and the other Olympian gods.

On the adjoining slab, the first on the south side of the altar, we recognize a goddess very like Rhea in nature—Kybele, mistress of the neighboring mountains of Phrygia. Riding on a lion, as she is usually represented, she dashes into the battle; the bold bodily form seen through the thin chiton which she wears; a mantle like a fluttering veil encircles her head. Up in the corner one of the eagles of Zeus flying toward Rhea holds ready in its talons a thunderbolt bound with sacred cords. Under the lion is the remnant of the body of a cuirass-clad giant. Kybele is equipped with bow and arrow, which it must be admitted are not known as her attributes. She is just in the act of taking an arrow out of the quiver with her right hand. In advance of the great goddess hastens along an attendant who has not with certainty been identified, perhaps Adrasteia. She wears a sleeved, woolen garment over which is a Doric chiton. Her mantle is blown out around her shoulders like a sail.

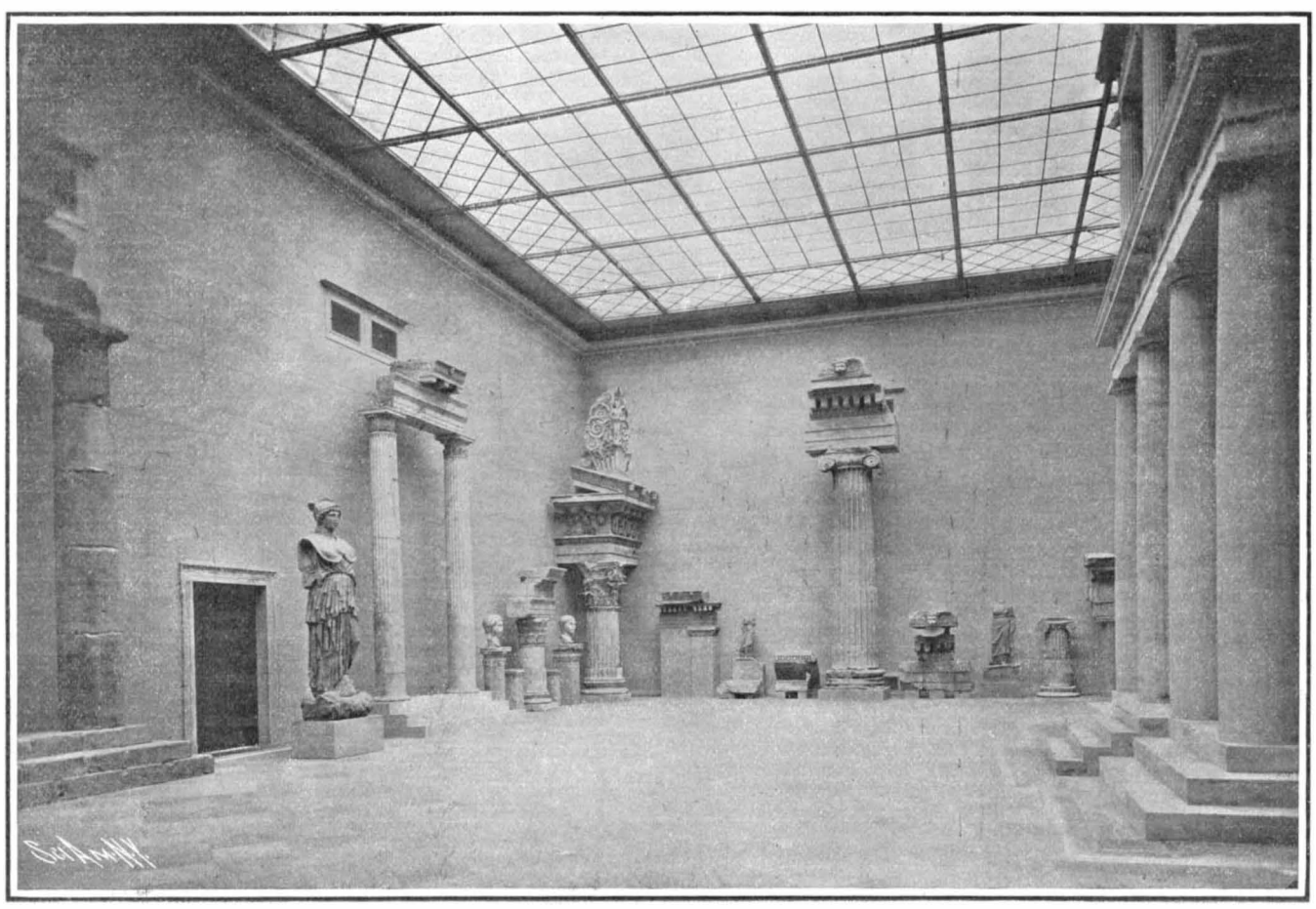
The attack of the Kybele group is led by a naked, bearded man of powerful form and hairy breast. He swings in his hands a mighty hammer, which he is about to let fall on a monstrous giant (Typhon?). The hammer is visible behind the god's back.



The Great Altar of Pergamon.

The giant, whose lower extremities are serpents, has the thick neck of a buffalo-ox, as well as the horns and the ears of the same animal. He throws himself with the entire weight of his body against an adversary; the latter has driven from beneath his sword up to its hilt into the former's breast.

At the left of the stairs comes first a bearded man, who gives the impression of being elderly. His costume consists of a mantle, a chiton flowing to his feet, and a high cap which looks like the skin of a fish. According to the inscription the god is Nereus, the father of Amphitrite. His right arm was made of a separate piece of marble and added on. He seems to be somewhat crowded into the background by the female figure hastening on before him, his wife, Doris, who in her prime enters the fierce battle. With her foot placed on the serpent of a giant, whose beard is just beginning to sprout, she pulls his hair. The empty scabbard which hangs at her side indicates that she was armed with a sword. The goddess wears a woolen garment with sleeves, over which is a short Doric chiton, and shoes made of



The Pergamon Marbles.

PERGAMON MARBLES IN THE PERGAMON MUSEUM OF BERLIN.

the skins of sea-weed, showing a reference to the water.

The god, an extremely strong figure, in short garment (exomis) from which stand out in bold relief his right leg and breast, is in all probability Okeanos accompanied by Tethys. In front of these two divinities, who fittingly form the conclusion of the representation of the battle, flee up the steps several giants. The first has fallen on his knee; another with serpent legs, farther up the stairs, screens himself with a shield. The space which follows must have been filled with the coiled serpent-leg. At the top the small space between the stairs and the platform is occupied by an eagle which opposes the serpent. There is also an eagle on the right wing opposite as well as on the southwest and southeast corners respectively.

In this manner the whole dynasty of gods fighting with the giants runs around the substructure of the altar. Among the number of these groups there may be mentioned the most splendid and the best-preserved of all, groups representing Athena and her adversaries. Athena, the daughter of Zeus, having seized by the hair a beautiful, vigorous, four-winged giant, drags him along with her as she strides violently forward. The giant, Alkyoneus, who, according to the legend, was immortal on the soil which gave him birth, and hence could only meet death away from his native place, in vain plants his feet on the ground.

Ge, the goddess of the earth, identified by the name to the left of her head and by the cornucopia at her side, rises out of the earth, and with uplifted hands implores mercy for her sons. Already the sacred serpent of Athena has coiled itself around his arms and legs, and has given him a fatal wound in the breast. His complete fall is foretold by Nike, the goddess of victory, who, floating down to the right of Athena, is about to place a crown on her head. The second opponent of Athena, Eukelados, between Alkyoneus and Porphyrion, already lies conquered on the ground. The legend tells us that Athena threw the island of Sicily on top of him. On the ground near the goddess is part of a dead giant in full armor.

Among the number of sculptures found in Pergamon may be mentioned the large statue of Athena Parthenos, a copy of the famous gold and ivory statue made by Phidias. The pedestal of the statue is ornamented with reliefs. This copy, the work of a Pergamene sculptor, stood in the principal room of the library.

To the right of this statue there is a part of the colonnade built perhaps by Kadrion (117 to 138 A. D.) which inclosed on three sides the sacred precinct of the Trajan temple from Pergamon. Of the large figures of Trajan and Hadrian, now shattered, which were set up in the temple as honorary statues, the heads are still extant and exhibited here, one on the capital of a column and the other on that of a pillar. Both the column and the pillar were part of the Hadrian colonnade.

Some of the architectural members of the gymnasium, a building which stood half way up the acropolis, and which also belongs to the Hadrian period, have been given a place here between the two heads above mentioned. Then follows a corner of the Trajan temple with its beautiful, slender corner acroterion.

To the right on Fig. 4 we show a portion of the stoa or colonnade which inclosed the sacred precinct of Athena in Pergamon, built by King Eumenes II. to give new splendor to the old sanctuary. A peculiar decoration of the colonnade was the parapet of the upper story with its reliefs representing weapons and various implements of war for both land and water.

The pieces here mentioned are but a few from among the great number of sculptures, reliefs, inscriptions, and pieces of architecture exhibited in this museum. Its whole contents offer not only an abundant material for study to archæologists, but also a singular delight to all friends of works of art.

RECENTLY PATENTED INVENTIONS.

Of Interest to Farmers.

BEET-PLOW.—E. G. SMART, Salinas, Cal. The invention refers to means for removing beets or other esculent tubers from the soil, and has for its object to provide a power-drawn plow having adjustable disks that by rotation raise the vegetables from the ground and leave them on the surface, cutting off vines and weeds when the disks are progressively moved along rows of the beets for their excavation from the soil.

Of General Interest.

CUTTING AND PUNCHING DEVICE.—J. EVANS and J. EVANS, Salt Lake City, Utah. The principal objects of this improvement are to provide means whereby a belt may be guided within the machine in such a manner as to provide for locating the lacing-holes and cutting off the end at the desired points, and, furthermore, to provide a simple and convenient arrangement of the punches and blades necessary for performing these operations and to secure a convenient and efficient arrangement of the punches and blades necessary for performing these operations and to secure an efficient leverage system for the punches and blades.

PROCESS FOR THE MANUFACTURE OF ARTIFICIAL PEARLS, ETC.—P. E. L. PERDRIZET, 4 Rue Elzévir, Paris, France. Imitation pearls manufactured by known processes, and more particularly the large variety, are too fragile when hollow and too heavy when solid, and the manufacture of pearls of irregular form which are termed "baroques," is more costly than that of pearls of regular form in consequence of a special molding process having to be adopted. This process obtains artificial pearls having a nacreous luster and in a high degree the qualities of strength and lightness and an irregularity of form which imparts an exact resemblance to genuine pearls, "baroques."

INTERCHANGEABLE JOURNAL.—J. H. OSTRANDER, Ticonderoga, N. Y. Among the several objects of this invention are: first, to render the journals readily interchangeable; second, to provide against displacement of the journal from its proper position; third, to give the journal such conformity as will enable it to be braced when in position, and, fourth, to provide constructional details affording peculiar advantages. It relates particularly to journals of the kind used upon rollers—for instance, in paper-mills.

APPARATUS FOR MAKING STEEL AND OTHER METALS.—E. C. WILLS, Trenton, N. J. In this case the invention is an improvement in apparatus for use in the manufacture of steel and the like, and relates particularly to the construction of the converter and the means for operating the several parts thereof and for admitting air and the like in the use of the apparatus.

SNATCH-BLOCK.—P. H. STROHMINGER, Mansfield, Ohio. This block is intended particularly for use by electric linemen, although it is useful in other connections. The object of the invention is to enable the snatch-block to be cheaply and durably constructed, at the same time avoiding the possibility of the block becoming accidentally unfastened, this being an important desideratum in case the block is used by electric linemen.

TWEEZERS.—E. C. ELLSWORTH, Cambridge, Vt. Although adapted for general use, the tweezers are specially designed for watchmakers for use in removing and replacing the escapement-lever of watches. The invention possesses special advantages, is cheap to manufacture and simple in construction. To the end above stated Mr. Ellsworth has invented the peculiar tweezers or, more definitely stated, an attachment to an ordinary pair of spring-tweezers.

Heating and Lighting.

SECTIONAL BOILER.—J. J. M. LANGE, Svendborg, Island of Funen, Denmark. This invention relates to an improved element, sectional, or joint boiler—that is to say, a boiler which can be set up directly from cast elements or sections all alike and which particularly serves for heating water or as a low-pressure boiler, for instance, in central heating arrangements and the like. It is easy to tend, being divided up into a number of small furnaces or stoves easily arranged as magazine-stoves. It may be used partially—that is, a larger or smaller number of furnaces may be lighted, according to the momentary need, whereby the remaining cold elements are left out of action.

OVEN-SCREEN.—B. MORGENSTEIN, Shenandoah, Pa. Better results are obtained in baking if a certain amount of moisture is introduced. In using this screen after it is introduced the receptacle which is on the side toward the baking-surface may be filled with a hose. The water now gradually flows through the contracted opening of the spout, down the screen and onto the surface adjacent to the grate and there vaporized, it passing with the hot air through the screen-opening or over the flap and is thus quite uniformly distributed over the goods. When necessary, the receptacle may be refilled.

Household Utilities.

WINDOW-SASH BALANCE AND LOCK.—T. PACHALI, SR., Reading, Pa. The purpose here is to provide a device applicable to window-sashes and frames which will dispense with the sash-weights ordinarily used and which will guide the sash up and down with least possible friction, and to provide means for adjusting the device to and from the sash, together with means for locking the sash closed or in any desired open position.

FOLDING BED.—J. D. FROMAN and T. M. LANHAM, Vevay, Ind. In this instance the invention relates to a bed which can be combined with a bookcase, settee, wardrobe, dresser, and various other kinds of furniture. The principal objects are to provide for folding a bed in such a manner that it will occupy much smaller space than has been the case heretofore, and especially to reduce the vertical space occupied by the bed in folded position.

Machines and Mechanical Devices.

LOADER.—J. C. MIRE, Belle Helene, La. It is the object in this case to provide a loader, more especially designed for conveniently and quickly loading sugar-cane, hay, or like material into wagons, carts, or other vehicles, the loader being simple and durable in construction, easily manipulated, readily moved about a field, and requiring but little manual labor to handle large quantities of the material in a comparatively short time.

Prime Movers and Their Accessories.

ROTARY ENGINE.—F. M. OBER and B. DUGAR, Morrisville, Vt. In this patent the invention has reference to a rotary steam or other elastic-fluid engine in which the rotor is provided with a number of piston-heads revolubly mounted thereon and coacting with abutments supported by the cylinder or stationary part.

CARBURETER FOR GAS-ENGINES.—O. MINTON, New York, N. Y. The improvement pertains to a device for mixing air and a combustible fuel for gas-engines, although it may be used for other purposes; and the principal object in view of the inventor is the provision for regulating the mixture of air and fuel to be admitted, and also the quantity.

POWER MECHANISM.—P. ADAMS, Lamar, Col. In this mechanism will be found improvements for aiding the working power for a device to be operated over a power initially derived from a steam or other motor, thus resulting in an economical use of motive agent, as an engine of comparatively small horse-power may be employed to perform work requiring a much greater horse-power.

Pertaining to Vehicles.

ARMORED-TIRE.—C. W. CATERSON, Franklin Forks, Pa. In this instance the invention refers to the tires of vehicles, and especially to pneumatic tires. The object is to produce an improved tire of the class popularly known as "armor-tires," the purpose being to present a substantially non-puncturable pneumatic tire which will have all the resilience and usual qualities of an ordinary pneumatic tire.

NOTE.—Copies of any of these patents will be furnished by Munn & Co. for ten cents each. Please state the name of the patentee, title of the invention, and date of this paper.

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Drying Machinery and Presses. Biles, Louisville, Ky.

Inquiry No. 7533.—For manufacturers of wire suitable for toasters; also for parties who supply thin sheet iron.

Handle & Spoke Mchy. Ober Mfg. Co., 10 Bell St., Chagrin Falls, O.

Inquiry No. 7534.—For manufacturers of or dealers in bird lime.

Sawmill machinery and outfits manufactured by the Lane Mfg. Co., Box 13, Montpelier, Vt.

Inquiry No. 7535.—For manufacturers of fiber brushes, or machines to make the same.

I sell patents. To buy, or having one to sell, write Chas. A. Scott, 719 Mutual Life Building, Buffalo, N. Y.

Inquiry No. 7536.—For manufacturers of wood fretwork.

WANTED.—Patented specialties of merit, to manufacture and market. Power Specialty Co., Detroit, Mich.

Inquiry No. 7537.—For makers of structural shapes of aluminum (small T-irons, angle irons and 3-16 inch thick flat sheets).

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Inquiry No. 7538.—Wanted, machinery for stamping letters on metal disks.

WANTED.—Draftsman for Patent Office drawings. Salary, $1,200. State experience. Address F. L. D., Box 773, New York.

Inquiry No. 7539.—Wanted, address of firms making a specialty of bending copper and brass tubes.

WANTED.—Ideas regarding patentable device for water well paste or mucilage bottle. Address Adhesive, P. O. Box 773, New York.

Inquiry No. 7540.—Wanted, castings and material to make a motor and dynamo of from ¼ to ½ h. p.

FOR SALE.—Paying up-to-date metal working plant. Best location; good building. $75,000, or will sell large interest to right man. Chance, Box 773, New York.

Inquiry No. 7541.—For dealers in rod-straightening machines, to straighten rods of machine steel.

WANTED.—A Young Man familiar with drafting to assist superintendent in an iron casting plant. Good opportunity for advancement if capable. Draftsman, Box 773, New York.

Inquiry No. 7542.—For makers of canning machinery, also of machinery for making the tin cans.

For Sale or Promoter Wanted.—Patent portable, reversible iron fire escape, *solid ladder*, any number of persons, height or window, operated from interior, no obstruction. Heath, 314 W. 141st Street, New York.

Inquiry No. 7543.—Wanted, machines for attaching or fastening metal buttons on cloth.

Manufacturers of patent articles, dies, metal stamping, screw machine work, hardware specialties, machinery tools and wood fibre products. Quadriga Manufacturing Company, 18 South Canal St., Chicago.

Inquiry No. 7544.—For manufacturers of mutoscopes.

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Inquiry No. 7545.—For makers of bench shapers; also of small screw-cutting lathes, other than the Barnes, Sebastian and Star.

Manufacturers of all kinds sheet metal goods. Vending, gum and chocolate, matches, cigars and cigarettes, amusement machines, made of pressed steel. Send samples. N.Y. Die and Model Works, 508 Pearl St., N.Y.

Inquiry No. 7546.—For manufacturers of spring, such as used in clocks; also for makers of light, small castings, as used in making locks.

INVENTIONS WANTED.—Undersigned will consider one or two good patented or patentable inventions to manufacture on royalty. Something in popular demand preferred. Honest treatment guaranteed. F. Raniville Company, Grand Rapids, Mich.

Inquiry No. 7547.—Wanted, machinery for the manufacture of wood alcohol.

FOR SALE.—A modern, up-to-date plant—established sixteen years. Suitable for woodworking of any kind. Direct freight tracks into factory. Wagon builders or automobile manufacturers would find a proposition worthy of most careful consideration in this offer. Address Sale, Box 773, New York.

Inquiry No. 7548.—Wanted, the makers of the Long Life Apparatus, for the purpose of purifying air in rooms.

Inquiry No. 7549.—Wanted, machinery for working dough in a bakery, with steam and hand power.

Inquiry No. 7550.—For the makers of the fastener called the "Security."

INDEX OF INVENTIONS

For which Letters Patent of the United States were Issued for the Week Ending November 21, 1905

AND EACH BEARING THAT DATE

See note at end of list about copies of these patents.]

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Acoustic diaphragm, J. H. Van Mater	804,903
Advertising and mailing card, L. D. Jones	805,016
Advertising device, clock controlled, H. C. Quick	805,028
Aging, mellowing, and purifying wines and liquors, apparatus for, J. F. & J. F. Duffy, Jr.	804,935
Agricultural implements, riding attachment for, N. H. Bloom	804,922
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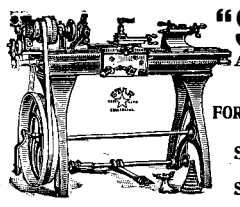

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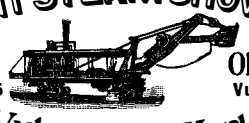

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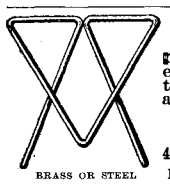

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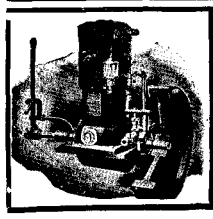

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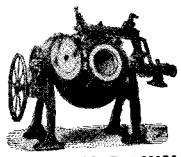

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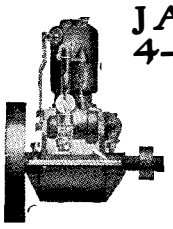

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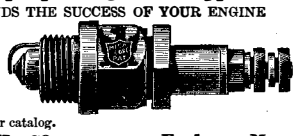

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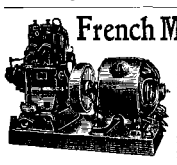

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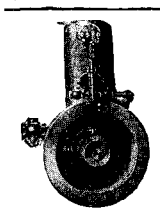

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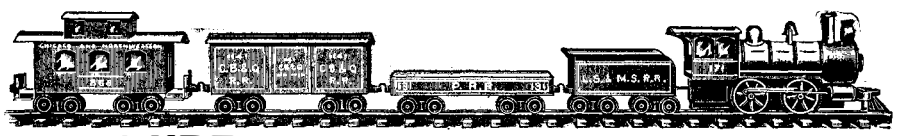

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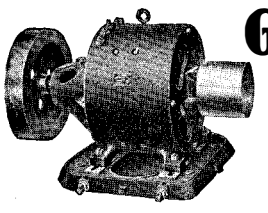

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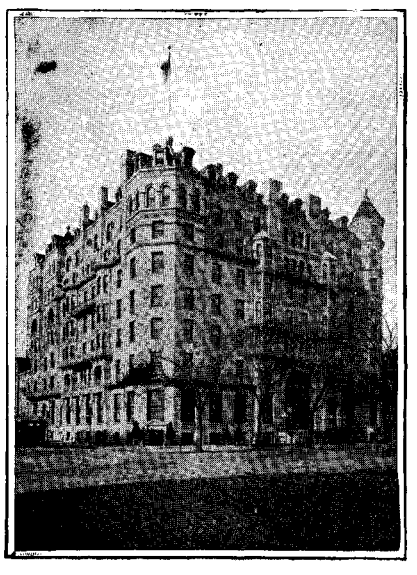

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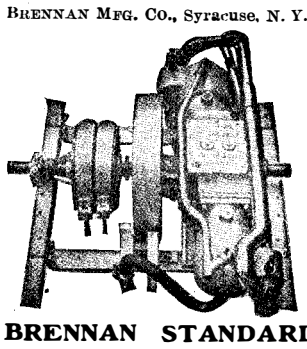

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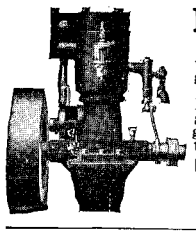

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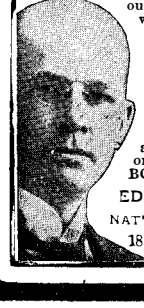

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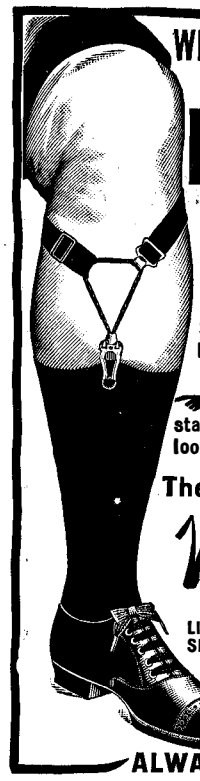

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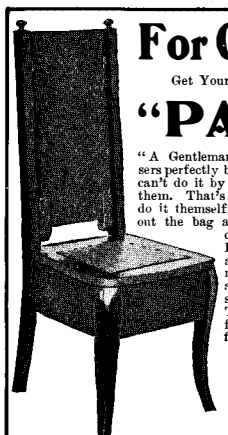

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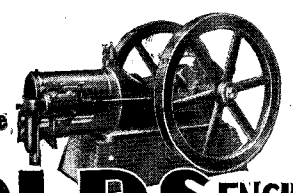

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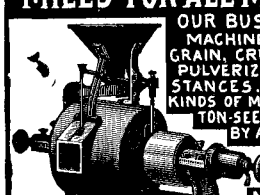

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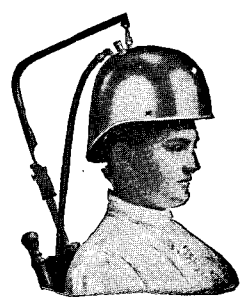

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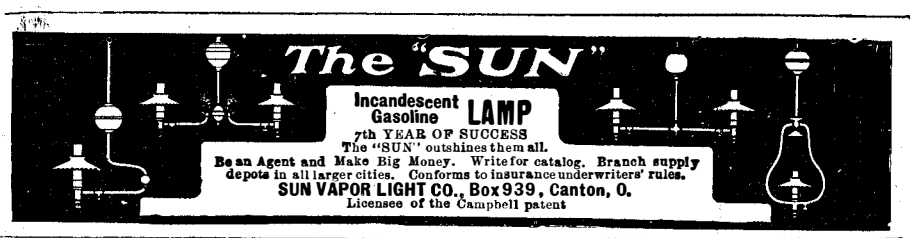

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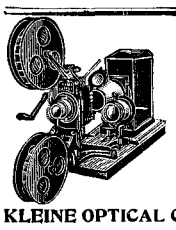

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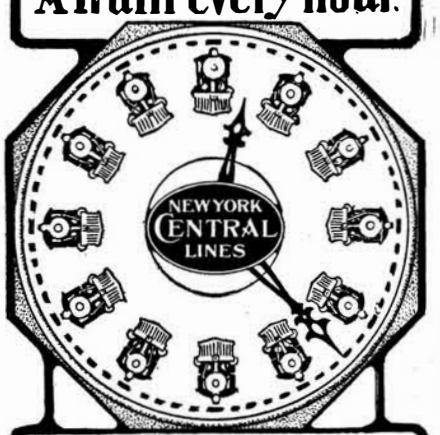

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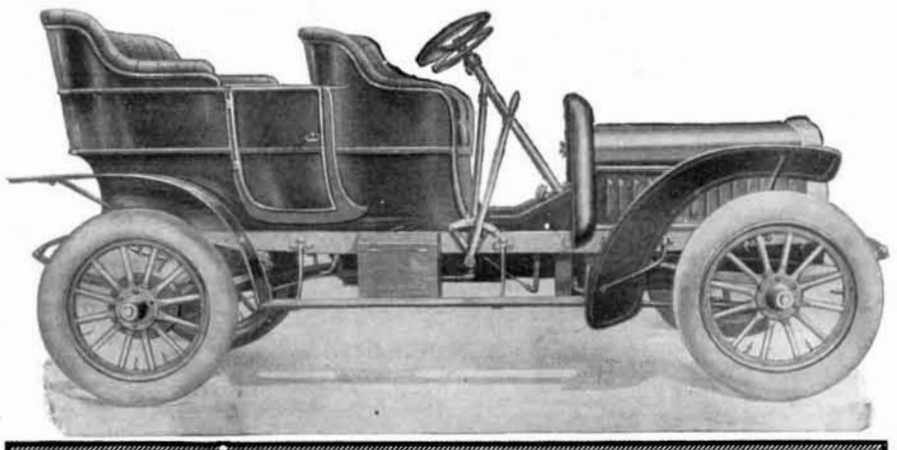

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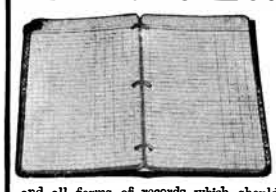

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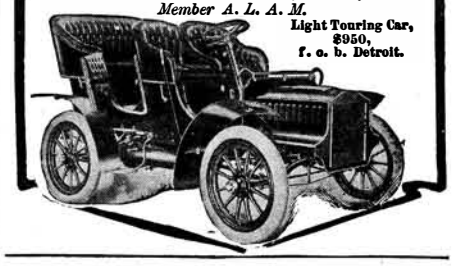

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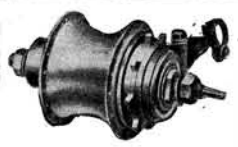

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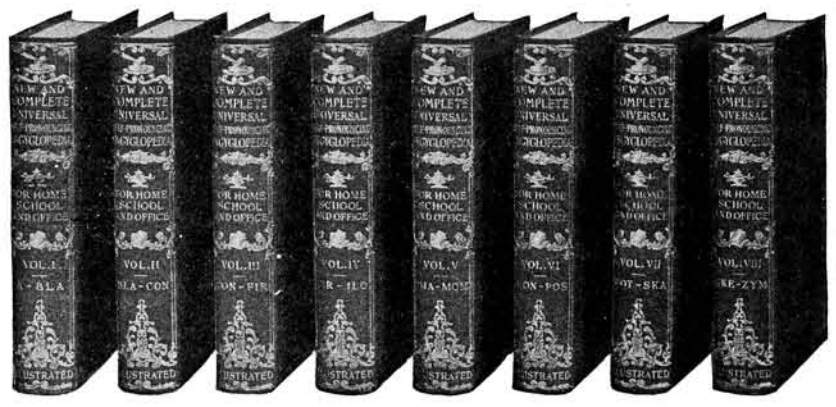

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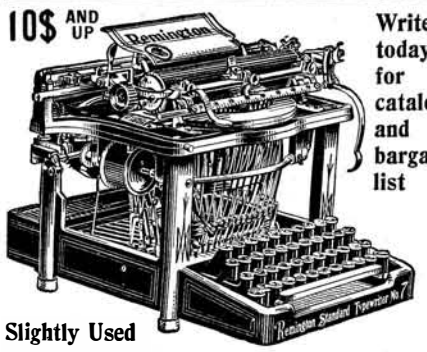

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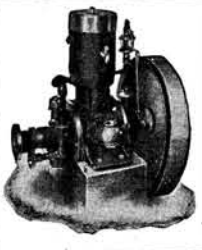

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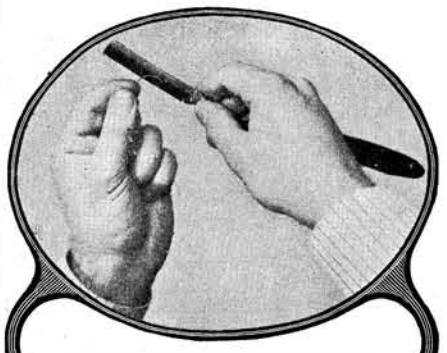

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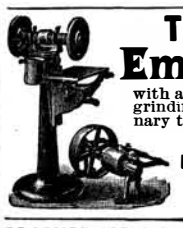

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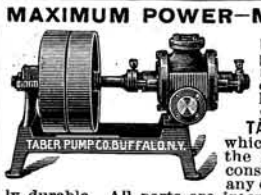

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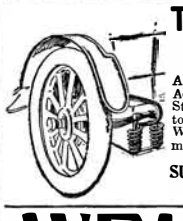

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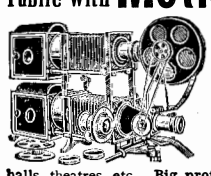

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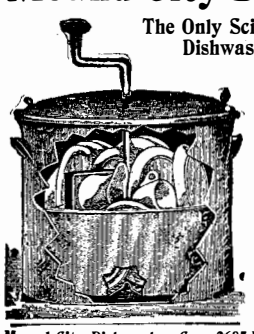

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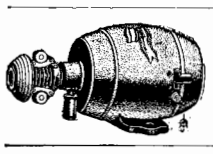

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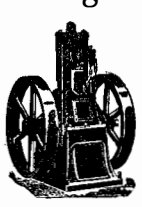

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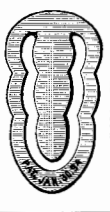

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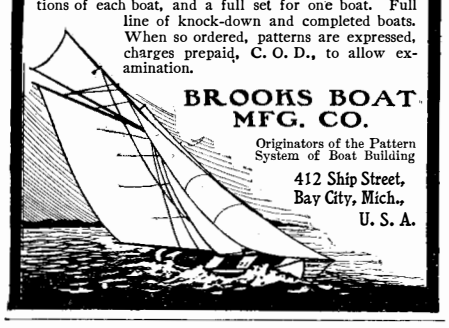

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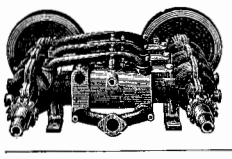

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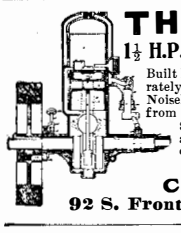

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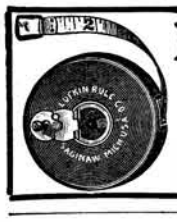

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